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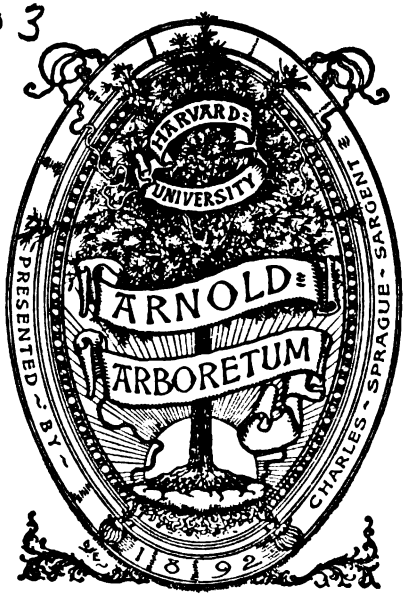
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ARNOLD
ARBORETUM
PRESENTED BY
CHARLES SPRAGUE SARGENT
1892

Vol. I

Proceedings of The Society of American Foresters

May, 1905

PROCEEDINGS

OF

THE SOCIETY OF AMERICAN FORESTERS

VOL. I MAY, 1905 No. 1

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The Society of American Foresters

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Vice-President, Overton W. Price
Secretary, George B. Sudworth
Treasurer, William L. Hall

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COMMITTEE ON ADMISSIONS

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Overton W. Price
F. E. Olmsted
William L. Hall
E. T. Allen

COMMITTEE ON MEETINGS

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OFFICES OF THE SOCIETY

Atlantic Building, Washington, D. C.

PROCEEDINGS
OF
THE SOCIETY OF AMERICAN FORESTERS

The publications of the Society are sent gratuitously to all members. Copies of the Proceedings may be obtained of the Secretary for 25 cents each number.

VOL. I MAY, 1905 No. 1

Forestry and Foresters

THEODORE ROOSEVELT

Delivered before the Society March 26, 1903

I have felt that the meeting this evening was of such a character as not merely to warrant but to require that I should break through my custom of not going out to make speeches of this sort, for I believe that there is no body of men who have it in their power to-day to do a greater service to the country than those engaged in the scientific study of, and practical application of, approved methods of forestry for the preservation of the woods of the United States. I am glad to see here this evening not only the officials, including the head of the Department of Agriculture, but such men as Governor Richards, who are most concerned in carrying out the policy of the Department of the Interior, because the forest policy of any country must be an essential part of its land policy.

And now, first and foremost, you can never afford to forget for one moment what is the object of our forest policy. That object is not to preserve the forests because

they are beautiful, though that is good in itself, nor because they are refuges for the wild creatures of the wilderness, though that, too, is good in itself; but the primary object of our forest policy, as of the land policy of the United States, is the making of prosperous homes. It is part of the traditional policy of home making of our country. Every other consideration comes as secondary. The whole effort of the Government in dealing with the forests must be directed to this end, keeping in view the fact that it is not only necessary to start the homes as prosperous, but to keep them so. That is why the forests have got to be kept. You can start a prosperous home by destroying the forests, but you cannot keep it prosperous that way.

And you are going to be able to make that policy permanently the policy of the country only in so far as you are able to make the people at large, and, above all, the people concretely interested in the results in the different localities, appreciative of what it means. Impress upon them the full recognition of the value of its policy, and make them earnest and zealous adherents of it. Keep in mind the fact that in a government such as ours it is out of the question to impose a policy like this from without. The policy, as a permanent policy can come only from the intelligent conviction of the people themselves that it is wise and useful; nay, indispensable. We shall decide, in the long run, whether or not we are to preserve or destroy the forests of the Rocky Mountains accordingly as we are or are not able to make the people of the mountain States hearty believers in the policy of forest preservation.

That is the only way in which this policy can be made a permanent success. You must convince the people of the truth—and it is the truth—that the success of home makers depends in the long run upon the wisdom with which the nation takes care of its forests. That seems a strong statement, but it is none too strong.

You yourselves have got to keep this practical object before your minds; to remember that a forest which contributes nothing to the wealth, progress, or safety of the country is of no interest to the Government, and should be of little interest to the forester. Your attention must be directed to the preservation of the forests, not as an end in itself, but as a means of preserving and increasing the prosperity of the nation. "Forestry is the preservation of forests by wise use," to quote a phrase I used in my first message to Congress. Keep before your minds that definition. Forestry does not mean abbreviating that use; it means making the forest useful not only to the settler, the rancher, the miner, the man who lives in the neighborhood, but, indirectly, to the man who may live hundreds of miles off down the course of some great river which has had its rise among the forest-bearing mountains.

The forest problem is in many ways the most vital internal problem in the United States. The more closely this statement is examined the more evident its truth becomes. In the arid regions of the West agriculture depends first of all upon the available water supply. In such a region forest protection alone can maintain the stream flow necessary for irrigation, and can prevent the great and destructive floods so ruinous to communities farther down the same streams.

The relation between the forests and the whole mineral industry is an extremely intimate one; for, as every man who has had experience in the West knows, mines cannot be developed without timber—usually not without timber close at hand. In many regions throughout the arid country, ore is more abundant than wood, and this means that if the ore is of low grade, the transportation of timber from any distance being out of the question, the use of the mine is limited by the amount of timber available.

The very existence of lumbering, of course—and lum-

bering is the fourth great industry of the United States—depends upon the success of our work as a nation in putting practical forestry into effective operation.

As it is with mining and lumbering, so it is in only a less degree with transportation, manufactures, commerce in general. The relation of all these industries to forestry is of the most intimate and dependent kind.

It is a matter for congratulation that so many of these great industries are now waking up to this fact; the railroads especially, managed as they are by men who are compelled to look ahead, who are obliged by the very nature of their profession to possess a keen insight into the future, have awakened to a clearer realization of the vast importance of the economic use both of timber and of forests.

Even the grazing industry, as it is carried on in the great West, which might at first sight appear to have little relation to forestry, is nevertheless closely related to it, because great areas of winter range, available and good for winter grazing, would be absolutely useless without the summer range in the mountains where the forest reserves lie.

As all of you know, the forest resources of our country are already seriously depleted. They can be renewed and maintained only by the co-operation of the forester with the practical man of business in all his types, but above all, with the lumberman. And the most striking and encouraging fact in the forest situation is that lumbermen are realizing that practical lumbering and practical forestry are allies, not enemies, and that the future of each depends upon the other. The resolutions passed at the last meeting of the representatives of the lumber interests, which occurred here in Washington, were a striking proof of this fact and a most encouraging feature of the present situation. So long as we could not make the men concerned in the great lumber industry realize that the foresters were endeavoring to work in their interest, and not against them,

the headway that could be made was but small. We shall be able to work effectively and bring about important results of a permanent character largely in proportion as we are able to convince those men, the men at the head of that great business, of the practical wisdom of what the foresters of the United States are seeking to accomplish.

In the last analysis, the attitude of the lumberman toward your work will be the chief factor in the success or failure of that work. In other words, gentlemen, I cannot too often say to you, as, indeed, it cannot be too often said to any body of men of high ideals and good scientific training who are endeavoring to accomplish work of worth for the country, that you must keep your ideals high and yet seek to realize them in practical ways.

The United States is exhausting its forest supplies far more rapidly than they are being produced. The situation is grave, and there is only one remedy. That remedy is the introduction of practical forestry on a large scale, and of course that is impossible without trained men, men trained in the closet, and also by actual field work under practical conditions.

You have created a new profession of the highest importance, of the highest usefulness to the State, and you are in honor bound to yourselves and the people to make that profession stand as high as any other profession, however intimately connected with our highest and finest development as a nation. You are engaged in pioneer work in a calling whose opportunities for public service are very great. Treat that calling seriously; remember how much it means to the country as a whole.

The profession you have adopted is one which touches the Republic on almost every side — political, social, industrial, commercial; to rise to its level you will need a wide acquaintance with the general life of the nation, and a view point both broad and high.

Any profession which makes you deal with your fellow-men at large makes it necessary that if you are to succeed you should understand what those fellow-men are, and not merely what they are thought to be by people who live in the closet or the parlor. You have got to know who the men are with whom you are to work, how they feel, how far you can go, when you have to stop, when it is both safe and necessary to push on.

I believe that the foresters of the United States will create a more effective system of forestry than we have yet seen. If not, gentlemen, if you do not, I shall feel that you have fallen behind your brethren in other callings, and I do not believe that you will fall behind them. Nowhere else is the development of a country more closely bound up with the creation and execution of a judicious forest policy. This is, of course, especially true of the West, but it is true of the East also. Fortunately in the West we have been able, relatively to the growth of the country, to begin at an earlier day, so that we have been able to establish great forest reserves in the Rocky Mountains instead of having to wait and attempt to get Congress to pay large sums for their creation, as we are now endeavoring to do in the Southern Appalachians.

In the administration of the national forest reserves, in the introduction of conservative lumbering on the timber tract of the lumberman and the woodlot of the farmer, in the practical solution of forest problems which effect well nigh every industry and every activity of the nation, the members of this society have an unexampled field before them. You have a heavy responsibility—every man that does serious work, work worth doing, has on him a heavy responsibility—for upon the development of your work the development of forestry in the United States and the production of the industries which depend upon it will largely rest. You have made a good beginning, and

I congratulate you upon it. Not only is a sound national forest policy coming rapidly into being, but the lumbermen of the country are proving their interest in forestry by practicing it.

Twenty years ago a meeting such as this to-night would have been impossible, and the desires we here express would have been treated as having no possible relation to practical life. I think that since the present Secretary of Agriculture first came into Congress here there has been a complete revolution in the attitude of the public mind toward this question. We have reached a point where American foresters trained in American forest schools are attacking American forest problems with success. That is the way to meet the larger work you have before you. You must instill your own ideals into the mass of your fellow-men and at the same time show your ability to work with them in practical and business fashion. This is the condition precedent to your being of use to the body politic.

The Society of American Foresters

(Organized Nov. 30, 1900.)

CONSTITUTION

Article I

Name

The name of this Society shall be The Society of American Foresters.

Article II

Object

The object of this Society shall be to further the cause of forestry in America by fostering a spirit of comradeship among foresters; by creating opportunities for a free interchange of views upon forestry and allied subjects; and by disseminating a knowledge of the purpose and achievements of forestry.

Article III

Membership

Sec. 1. Members may be Active, Associate, or Honorary.

Sec. 2. Active members shall be professional foresters of achievement, whose field of work lies within the United States or its possessions.

Sec. 3. Associate members shall be chosen from those gentlemen, not professional foresters, who have rendered distinguished service to the cause of American forestry. They may attend all meetings of the Society, may take part in its discussions, but shall not be entitled to vote.

Sec. 4. Honorary members shall be chosen from professional foresters of achievement whose field of work lies outside the United States and its possessions. They may attend all meetings of the Society, may take part in its discussions, but shall not be entitled to vote.

Sec. 5. Any Active member may propose names of candidates for Active, Associate, or Honorary membership. Such names shall be submitted in writing to the Committee on Admissions, which shall report to the Society the names which it approves. Votes upon the names of candidates approved by the Committee on Admissions may be cast either in person or by letter. An adverse vote of one-tenth of the members voting, shall exclude from membership, providing the members voting comprise two-thirds of the Active membership of the Society, and provided that not less than three adverse votes are cast. Each proposal for membership shall be accompanied by a brief biographical sketch, giving the qualifications of the candidate for admission to the Society.

Sec. 6. Charges of conduct unbecoming a member may be preferred by any Active member. Such charges shall be made in writing to the Committee on Admissions, which shall without delay investigate them and report to the Society. A two-thirds vote of the Active members shall be necessary to suspend or expel.

ARTICLE IV

Officers

Sec. 1. The officers of this Society shall be a President, a Vice-President, a Secretary, and a Treasurer.

Sec. 2. The officers shall be elected from the Active members separately by ballot at the first executive meeting of the calendar year, and shall serve one year, or until their successors are elected.

Sec. 3. The President shall preside at the meetings of the Society, shall appoint the committees hereinafter designated, and shall perform all other duties incident to his office.

Sec. 4. In the absence of the President, the Vice-President shall preside at the meetings of the Society.

Sec. 5. The Secretary shall keep the minutes of the Society, shall conduct its correspondence, shall announce its meetings, and shall be custodian of its permanent records.

Sec. 6. The Treasurer shall collect all moneys due the Society and have custody of all moneys received. He shall deposit and expend the latter only in such manner as the Executive Committee shall direct.

ARTICLE V

Committees

Sec. 1. The following standing committees, composed of Active members, shall be elected by the Society or appointed by the President, as hereinafter specified, at or as soon as possible after each annual meeting: Executive Committee, Committee on Admissions, Committee on Meetings, and Committee on Publications.

Sec. 2. The Executive Committee shall be appointed by the President, shall consist of five (5) members, and shall choose its own chairman. Three (3) members shall constitute a quorum. This Committee shall control all funds and shall perform any other executive duties delegated to it by the Society.

Sec. 3. The Committee on Admissions shall be elected by the Society, shall consist of five (5) members, and shall choose its own chairman. It shall consider all names proposed for membership and shall recommend for election only those candidates who in its judgment are qualified

for admission to the Society. It shall forward through the Secretary the names and biographical sketches of such candidates, and any other necessary information, to all Active members, who shall vote upon them either by letter or in person. A vote upon such candidates shall be taken at the first executive meeting after the expiration of one month from the date upon which their names were forwarded to Active members. The names and papers of those whom the Committee does not recommend for election shall be returned to the members by whom they were proposed. Appeal from the decision of the Committee on Admissions may be taken to the Society, through the written demand of one-fourth of the Active members, addressed to the President. The Committee on Admissions shall also, as provided in Article III, Sec. 6, investigate charges preferred against members and report upon them to the Society.

Sec. 4. The Committee on Meetings shall be appointed by the President, shall consist of three (3) members, and shall choose its own chairman. It shall select the speakers, subjects, and dates for the meetings of the Society.

Sec. 5. The Committee on Publications shall be appointed by the President, shall consist of three (3) members, and shall choose its own chairman. It shall consider papers read before the Society, or otherwise submitted to it, shall approve or reject them for publication, and shall transact the business necessary to that end.

ARTICLE VI

Meetings

Sec. 1. The Society shall hold executive meetings and open meetings during such portion of the year as the Committee on Meetings may decide.

Sec. 2. Executive meetings shall be open to members only, and shall be held upon the first Thursday of each month within the period heretofore specified. They shall be for the transaction of business and the discussion of any subject selected by the Committee on Meetings.

Sec. 3. Open meetings may be attended by members and by guests of the Society, and shall be held weekly within the period heretofore specified, except upon the first Thursday of each month or when otherwise directed by the Committee on Meetings. The Society may hold such field meetings as the Society or the Committee on Meetings may direct.

Sec. 4. Special meetings shall be called only at the direction of the President.

Sec. 5. A quorum shall consist of nine (9) Active members.

ARTICLE VII

Dues

Sec. 1. The annual dues of Active members shall be five (5) dollars, payable in advance upon the first day of January. Members elected during the first half of the calendar year shall pay dues for the current year. Members elected during the second half of the calendar year shall pay no dues for the current year.

Sec. 2. Associate and Honorary members shall pay no dues.

ARTICLE VIII

Amendments

This Constitution may be amended by a three-fourths (¾) vote of the Active members present at any executive meeting of the Society, after due notice of the intention has been given to all Active members at least two weeks in advance.

Active Members

Alfred Akerman . . . . . Boston, Mass.
B. A. (Georgia, 1898); M. F. (Yale, 1902)
State Forester of Massachusetts

Edward Tyson Allen . . . . . Washington, D. C.
Bureau of Forestry, U. S. Dept. of Agriculture

Horace B. Ayres . . . . . Aitkin, Minn.

Raymond Eli Benedict . . . . . Washington, D. C.
Bureau of Forestry, U. S. Dept. of Agriculture

Edward Andrew Braniff . . . . . Washington, D. C.
Bureau of Forestry, U. S. Dept. of Agriculture

Ralph Clement Bryant . . . . . Manila, P. I.
F. E. (Cornell, 1900)
Bureau of Forestry, Dept. of the Interior

Austin Cary . . . . . Brunswick, Maine.
B. A. (Bowdoin, 1887); M. A. (Bowdoin, 1890)
Consulting Forester

Charles Sidney Chapman . . . . . Washington, D. C.
B. Agr. (Conn. Agr. Col., 1900); M. F. (Yale, 1902)
Bureau of Forestry, U. S. Dept. of Agriculture

Herman Haupt Chapman . . . . . Washington, D. C.
B. S. (Minn., 1896); B. Agr. (Minn., 1899); M. F. (Yale, 1904)
Bureau of Forestry, U. S. Dept. of Agriculture

Alfred Knight Chittenden . . . . . Washington, D. C.
Ph. B. (Yale, 1900); M. F. (Yale, 1902)
Bureau of Forestry, U. S. Dept. of Agriculture

Willard Weld Clark . . . . . Manila, P. I.
F. E. (Cornell, 1902)
Bureau of Forestry, Dept. of the Interior

George Edward Clement . . . . . Washington, D. C.
A. B. (Harvard, 1900); M. F. (Yale, 1902)
Bureau of Forestry, U. S. Dept. of Agriculture

George Lemon Clothier . . . . . Washington, D. C.
B. S. (Kans. State Agr. Col., 1892); M. S. (K. S. A. C., 1899)
M. F. (Yale, 1903)
Bureau of Forestry, U. S. Dept. of Agriculture

Albert Williams Cooper . . . . . Washington, D. C.
A. B. (Harvard, 1901); M. F. (Yale, 1903)
Bureau of Forestry, U. S. Dept. of Agriculture

Hugh McCollum Curran . . . . . Washington, D. C.
B. S. (N. C. Col. Agr. and Mech. Arts, 1898)
Bureau of Forestry, U. S. Dept. of Agriculture

Coert DuBois . . . . . Washington, D. C.
Bureau of Forestry, U. S. Dept. of Agriculture

Bernhard Eduard Fernow . . . . . Ithaca, N. Y.
LL. D. (Wisconsin, 1897)
Consulting Forest Engineer

Richard Thornton Fisher . . . . . Cambridge, Mass.
A. B. (Harvard, 1898)
Instructor in Forestry, Harvard University

John Foley . . . . . Washington, D. C.
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Wesley Johnson Gardner . . . . . Washington, D. C.
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Alfred Gaskill . . . . . Washington, D. C.
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John Clayton Gifford . . . . . Princeton, N. J.
B. S. (Swarthmore, 1890); D. OEc. (Bavaria, 1899)
Consulting Forest Engineer

Henry Solon Graves . . . . . New Haven, Conn.
B. A. (Yale, 1892); M. A. (Yale, 1901)
Director, Yale Forest School

Edward Merriam Griffith . . . . . Madison, Wis.
Supt. of Forests, Dept. of State Forestry

Henry Grinnell . . . . . Washington, D. C.
B. S. (Trinity [Conn.], 1897)
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John Henry Hatton . . . . . Washington, D. C.
B. S. (S. Dak. Agr. Col., 1901)
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Austin Foster Hawes . . . . . New Haven, Conn.
B. A. (Tufts, 1901); M. F. (Yale, 1903)
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Supt. of Forestry, Bureau of Agriculture and Forestry

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Smith Riley . . . . . Washington, D. C.
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Filibert Roth . . . . . Ann Arbor, Mich.
B. S. (Mich, 1890)
Professor of Forestry, University of Michigan

Joseph Trimble Rothrock . . . . . Philadelphia, Pa.
B. S. (Harvard, 1864); M. D. (Penna., 1867)
Dept. of Botany, University of Pennsylvania

Carl Alwin Schenck . . . . . Biltmore, N. C.
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Associate Members

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U. S. M. A., 1882; LL.B. (Yale, 1895)
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Christopher Columbus Andrews . . . . St. Paul, Minn.
Chief Fire Warden, State of Minnesota

Charles Edwin Bessey . . . . . Lincoln, Neb.
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Professor of Botany, University of Nebraska

Frank Swett Black . . . . . Troy, N. Y.
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Meetings

From the organization of the Society to the Spring of 1904, meetings were held and subjects presented for discussion as given in the following program. Those papers which are of permanent value will be printed in early numbers of the Proceedings of the Society.

1900—1901

November 30. Meeting for the Organization of a Society

December 13. Meeting at which the Society was consituted

January 3. Executive Meeting

January 24. Some Forest Features of the Sierra Reserve
GEORGE B. SUDWORTH

January 31. Forest Management in the Dehra Dun Conservancy, British India
F. E. OLMSTED

February 7. Executive Meeting

February 14. Some Principles of Field Photography
EDWARD BLOCK

February 21. Forest Conditions in the Black Hills Forest Reserve
E. M. GRIFFITH

February 28. Some Economic Features of the Southern Appalachian Forests
H. B. AYRES

March 7. Executive Meeting

March 14. Timber and Lumbering in Washington
EDWARD T. ALLEN

March 21. Forest Problems in the Southern Pine Belt
J. A. HOLMES

March 28. Commercial Forest Plantations in the Middle West
WM. L. HALL

April 4. Executive Meeting

The Study and Practice of Silviculture
HENRY S. GRAVES

April 11. The Forests of the Olympic Peninsula, Washington
HENRY GANNETT

April 17. The Point of View in Forest Work
GIFFORD PINCHOT

1901—1902

November 21. The Immediate Future in Forest Work
GIFFORD PINCHOT

January 2. Executive Meeting

January 6. Conservative Lumbering in Middle Tennessee
JOHN FOLEY

January 16. Financial Aspects of American Forestry
HENRY S. GRAVES

January 23. Forest Problems in the Priest River Reserve
EDWARD T. ALLEN

January 30. Grazing in the Black Mesa Forest Reserve
ALBERT F. POTTER

February 6. Executive Meeting

February 13. Making a Hardwood Working Plan
H. J. TOMPKINS

Address, THE SECRETARY OF AGRICULTURE

February 18. Special Executive Meeting

February 27. The Grand Canyon Forest Reserve
HENRY GANNETT

March 6. Executive Meeting

March 13. The Petrified Forests of the United States
LESTER F. WARD

March 20. The Silvicultural Study of Longleaf Pine in Virgin Forest
G. FRED SCHWARZ

March 27. The Collection of Data for a Coast Pine Working Plan in South Carolina THOMAS H. SHERRARD

April 3. Executive Meeting

April 10. The San Francisco Mountains Forest Reserve JOHN B. LEIBERG

1903

January 15. Executive Meeting

January 29. The Management of Woodlots in New England R. T. FISHER

February 5. Executive Meeting

February 12. Impressions of Philippine Forests GIFFORD PINCHOT

February 19. The Relation of Forest Entomology to Forest Management A. D. HOPKINS

February 26. The Growth of Planted White Pine in New England HAROLD B. KEMPTON

March 12. Silviculture Applied to Virgin Forest Conditions ALFRED GASKILL

March 19. The Reclamation Law and Its Relation to Forestry F. H. NEWELL

March 26. Address, THE PRESIDENT OF THE UNITED STATES

The Application and Possibilities of the Federal Forest Reserve Policy EDWARD T. ALLEN

April 2. Executive Meeting

April 9. The Relation of Proposed Forest Reserves in Utah to the Live Stock Industry ALBERT F. POTTER

April 16. The Silvicultural Problems of a Working Plan in Maine WILLIAM. C. HODGE, JR.

April 23. A Working Plan for a Longleaf Pine Tract in Texas THOMAS H. SHERRARD

April 30. The Present Possibilities of Forest Work in Michigan
FILIBERT ROTH

May 7. Executive Meeting

May 28. Executive Meeting

1903—1904

December 10. Executive Meeting

December 17. The Proposed Forest Reserve in Southeastern Alaska
W. A. LANGILLE

January 7. Executive Meeting

January 15. A Spruce and Hardwood Problem in West Virginia
JOHN FOLEY

January 21. Forest Principles applied to the Improvement and Formation of Maple Sugar Groves
WILLIAM F. HUBBARD

January 28. Necessity for Saving the Forest on the Watershed of the Sacramento River, California
J. B. LIPPINCOTT

Application of the Reclamation Act in Arizona
A. P. DAVIS

February 5. Executive Meeting

February 11. Commercial Study of Chestnut in Maryland
RAPHAEL ZON

Progress in Forest Planting on the Dismal River Reserve, Nebraska
CHAS. A. SCOTT

February 18. Forest Reserve Problems in Northern California
ALBERT F. POTTER
H. J. TOMPKINS
WILLIAM C. HODGE, JR.

February 25. Sivicultural Problems in Forest Management, White Mountains, New Hampshire
T. S. WOOLSEY, JR.

Factors Influencing Forest Reproduction in Northern New Mexico AUSTIN F. HAWES

March 3. Executive Meeting

March 5. Special Executive Meeting

March 10. The Work of the Bureau of Forestry in Wood Preservation HERMANN VON SCHRENK

The Disposal of Public Lands
GEORGE W. WOODRUFF

March 17. Collecting and Observing Forest Insects
A. D. HOPKINS

March 24. The Forest Reserve Situation in Arizona, Colorado, Idaho, and Montana F. E. OLMSTED
EDWARD T. ALLEN

March 31. The Characteristic Root Growth of Tree Seedlings JAMES W. TOUMEY

April 7. Executive Meeting

April 14. The Study of Forest Trees
GEO. B. SUDWORTH

Sivicultural Studies of Longleaf Pine for a Working Plan in Central Alabama FRANKLIN W. REED

April 21. Sanitation and First Aid for Camping Parties
WALTER D. MCCAW

The Growth of Forest Bamboos
DAVID G. FAIRCHILD

April 28 Results of a Rocky Mountain Forest Fire studied Fifty Years after its Occurrence W. J. GARDNER

Forest Planting on Flood-Damaged Lands in the Kansas River Valley GEORGE L. CLOTHIER

May 5. Executive meeting

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November 1905

PROCEEDINGS
OF
THE SOCIETY OF AMERICAN FORESTERS

VOL. I NOVEMBER, 1905 No. 2

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PROCEEDINGS
OF
THE SOCIETY OF AMERICAN FORESTERS

The publications of the Society are sent gratuitously to all members. Copies of the Proceedings may be obtained of the Secretary for 25 cents each number.

VOL. I NOVEMBER, 1905 No. 2

WILLIAM F. HUBBARD

On July 17, 1905, the Society suffered a severe loss in the death by drowning of one of its active members: William Fairchild Hubbard. Mr. Hubbard, though only twenty-seven years old, had repeatedly proved his value to the profession by his achievements in many parts of the country, and under widely varying conditions. As a forester he accomplished much through his energy, knowledge and thorough technical training, but his personality also made him strong. Few men in the Society attracted others as he did, and few so won the confidence and respect of those who were able to further the cause for which he worked so faithfully.

On September 1, the Society held a special meeting and adopted the following resolutions:

WHEREAS, The Society of American Foresters has lost by the death of William Fairchild Hubbard, one of its members, be it

Resolved, That the Society of American Foresters record its appreciation of his ability and achievements as a forester, its deep sense of the loss sustained by the Society and the profession in the premature death of one who gave such promise of further usefulness, its esteem for his worth as a man, its sorrow in the loss of his fellowship, and its sympathy with his many friends; and be it further

Resolved, That these resolutions be entered in the minutes of the Society and that a copy be transmitted to his family.

THE RECLAMATION LAW AND ITS RELATION TO FORESTRY

F. H. NEWELL, CHIEF ENGINEER, RECLAMATION SERVICE

Delivered before the Society March 19, 1903

The Reclamation Law of June 17, 1902, authorizes the Secretary of the Interior to withdraw temporarily, pending survey, certain areas of land which might otherwise be taken up by speculators. Under this law the temporary withdrawal of various tracts has been made in each of the western States. These temporary withdrawals give time to make the surveys. The lands are withdrawn from all entry, except under the Homestead Act; a man can make a homestead entry, but cannot commute for a cash payment as under ordinary provisions. The homestead may also be cut down from 160 acres to forty acres if the Secretary so decides. Thus speculators taking the lands in advance of the determination of a project do so at their own risk.

A diagram printed in the first Annual Report of the Reclamation Service has been prepared to show the location of the vacant public lands. The areas in black indicate the lands which are now in private ownership. In North Dakota, for example, about one-half the lands are in private ownership; there are vacant lands in South Dakota and Nebraska, but in the semi-arid portions of Kansas and of eastern Colorado nearly all the public lands are gone. From the vicinity of Denver to the Sierra Nevada nine-tenths of all the lands are in public ownership. In the great central valley of California, however, all the lands formerly public are now in private ownership.

The broad bands running across the map indicate the location of the railroad grants in which the alternate sections belong to the railroad companies. A vast area of lands in the arid regions, aggregating one-third of the United States,

is vacant and open to entry by any citizen. Here and there in this vast extent, lands have been taken up at points where the people have been able to obtain a water supply. Such lands when irrigated have been found to be extremely productive.

The development of the West by the Government, or by private enterprise, is a matter which can not be controlled by State lines. The principal rivers from which a water supply is obtained for irrigation rise in one State and flow into another. There is hardly any large river, with the exception notably of the Humboldt, that is entirely included in one State. The development of these rivers, and their utilization is a matter that must be taken up by natural divisions or drainage basins and not by State boundaries.

Nearly all of the vacant public land, which as before stated comprises one-third of the United States, is now included in some grazing district, or is claimed by some sheep or cattle owner as his range. The controversies between the different classes of grazers have been intense, and have resulted in pushing the grazing up into the forest reserves. This is one of our most serious problems, and one which is giving more trouble in the administration of the forest reserves than any other. The grazing of sheep and cattle is the dominating industry of the arid land, the industry around which at present revolve all others.

The free or open range of the United States extends practically from the Mexican border to Canada. Herds of cattle grown in Texas are driven across the free range up into Montana to be fed. The business of driving cattle is not so extensive as in the old days when the cattle trails ran continuously from Texas into Montana; but when the area of land is considered, grazing is the principal industry in the West. It is the foundation of much of the irrigation development, because the products of irrigated lands are usually used for feeding cattle.

Much of the vacant land of the semi-arid region is not only open range, but a great deal of it has at one time or another been settled upon. Attempts have been made to establish homes and towns. One may still see the remains of them in eastern Colorado, in western Kansas, and in western Nebraska. Many of these "boom" cities collapsed because of the lack of water. The people came in at a time of abnormal rainfall, and when the rainfall failed, the towns were deserted, the land reverted to the United States or to the loan companies and the people in the East who had loaned money on western mortgages.

East of the city of Denver is the locality where the rain-belters attempted to make homes. They were people who believed that the country when settled would have plenty of rainfall. They pressed westward and forward into the semi-arid regions under the assumption that the breaking of the sod, the building of railroads and telegraph lines would bring greater rainfall, and that they would then make a comfortable living off the land. Some have succeeded, others have nearly starved and have "gone back to live with their wives' folks" or up into the mountains to the mines.

Many other sections of the arid and semi-arid country have been leased to cattlemen for grazing purposes. The laws of some of the States require that the State lands shall be sold for not less than ten dollars an acre, hence large tracts will probably never be sold, though they can be rented for grazing at a few cents per acre.

The situation in Utah is notable as regards private ownership. A string of small holdings is scattered along from Ogden and Salt Lake south through the central valleys. The great bulk of the land still belongs to the United States, and there are opportunites for reclamation of arid lands. The Uncompahgre Indian Reserve contains some particularly valuable land. It is traversed by a good river,

capable of being used in the development of thousands of acres. There are also other opportunities in the State, many of them dependent on water supply from the forest reserves. Up to the present the forest reserves that have been created are small. There is great agitation now, petitions and counter-petitions for and against the creation of these forest reserves. Every town wants a little forest reserve of its own, but does not care for a reserve in any other place. Each community desires to protect its own watershed, but would like to run its cattle over all the rest of the country. The sheepmen do not want any reserves, and the other people wish to shut the sheepmen out.

In the investigations of the extent to which arid land can be reclaimed, the essential preliminary is that of making a map. We must have good maps, not only of the streams and irrigable lands, but of every elevation of surface. The topographic maps of the Geological Survey are familiar to all. In the work of the Reclamation Service similar maps are made in greater detail, sometimes on a scale of four inches to the mile instead of one inch to the mile, or four times the ordinary size. Not only are such maps being made, but an account of stock of the public lands is being taken and maps prepared showing where the private lands are located.

The maps prepared for the reclamation projects, and the account of stock taken, showing the location of the public lands, are valuable in the matter of creating and defining forest reserves. These maps exhibit from the standpoint of reclamation where the lands are that may possibly be utilized. Only a small proportion of the public lands will be reclaimed, but it is important to know where the land is and what are the surroundings.

The funds available for reclamation purposes are inversely proportional to the needs of the States. Arizona and Nevada, needing funds the most, have the least, while North

Dakota and Oklahoma, where it is most difficult to find good opportunities for reclamation, have millions of dollars. In short, where the opportunities are few, or relatively few, we have great funds to expend. For example, in Oklahoma it is difficult to find good reclamation opportunities, because most of the land is good for dry farming, yet it is one of the conditions of the Reclamation Act that the Secretary of the Interior must meet in this work.

In studying the various projects, not only are maps prepared of the land and the opportunities for reclamation noted, but the actual amount of water available must be ascertained. This involves a large amount of careful work by the hydrographers.

The Government does not take up this matter in a clear field. There are a great many irrigation works already built, good, bad, and indifferent, and the opportunities for easy reclamation have been taken up. The Secretary is confronted with the condition that all the difficult things are left, and all the opportunities are complicated with vested rights. It looks simple to build a reservoir, but when it is found that there are numerous vested rights on the stream that have to be satisfied, and that part of each stream is in public ownership and part in private, there results much confusion as regards what can be done, and it requires infinite patience and tact to bring about practical results.

Many of the structures built by private enterprise are extremely instructive, not because they have succeeded, but because they have failed. One of the structures which have afforded valuable lessons is the dam at Austin, Tex. It is 1200 feet long, and is one of the best in appearance that has been built. It cost the city of Austin over half a million dollars, but was built without consideration of the water supply. Everybody talked about the need of a dam. All knew about the stream by personal observation, and

without finding out the ultimate facts of the problem, the people went ahead with the building. When it was to be built, old inhabitants said "There is plenty of water," and the engineers did not stop to investigate, but built the dam as instructed. When the dam was built, it was found that there was only a small part of the amount of water that was necessary to supply the needed power. It stood for fourteen years, and then came a flood, when the water rose 11 feet above the top, pushing the dam out. Several hundred feet of the dam apparently slid down stream on its foundations. It was based on horizontally bedded limestone, that apparently slipped forward taking the dam with it. This failure illustrates the necessity of knowing the foundations before a structure is put on them, as well as the water supply.

Another reservoir in New Mexico is situated in a country of gypsum. Gypsum looks like good firm rock, yet under the influence of the waves it has dissolved like hard sugar, and the water can be seen disappearing down into the caverns as though it were flowing into the solid stone.

I will now speak briefly of a number of projects which have been approved by the Secretary of the Interior. One of these is at the foot of the Rocky Mountains in Montana, where are some glacial lakes. Under present conditions the water from this region flows northerly into Canada and into the Saskatchewan River. It is proposed to store the floods that otherwise pass into Canada and are lost, and to divert them easterly upon the good land in the Milk River Valley of Montana. Surveys have been made to show the advisability of diverting the water across a low ridge into the Milk River, which flows through Canada and then back into the United States. This involves an international problem. The British Minister has complained because of the proposed holding of this flood water in Canada, and in reply we have shown that these flood

waters have been a source of annoyance to the Canadians and not a benefit. The Canadians say "If you send the stored water down through Canada, we will take it over and divert it to our own land." In reply it has been said "If you attempt to divert this water in Canada, we can send it by a more expensive route through the United States. The other route is not so good, but if we must, we can do it that way."

Another project is on the Gunnison, a tributary to Grand River in Colorado, which flows in a narrow canyon through a solid granite uplift. This gorge is more impressive in some ways than the Grand Canyon of the Colorado, for the eye can take it in all at once. This chasm had never been explored until Mr. A. L. Fellows, a Yale graduate, one of the engineers of the Reclamation Service, decided to go there to see what was in the canyon. People had tried to go through before, but had been wrecked and had had a hard time getting back. Mr. Fellows decided that there was no use again trying a boat, but believed he could go through by swimming and climbing. He decided that one of his pneumatic mattresses, a few rubber bags to hold his camera and provisions, and an extra suit of underwear, were sufficient; so, with a good stout companion and his equipment, he made the attempt. The great problem was that of going over the falls. Reaching these he could see and hear the water below, but on account of the narrow walls he could not get any idea of the depth of the falls. The trip took him ten days, and he had many hardships, was banged against the rocks and drawn under at whirlpools, but was never hurt badly. He located the head of the tunnel, which when built will extend through the side of the mountain 30,000 feet, or over five miles, to the open valley beyond. Estimates are now being made of the cost and advisability of build-

ing the tunnel and of taking the Gunnison through to the lands in the vicinity of Montrose, Colorado.

The largest project is one which may not be completed for many years. It is one which is comparable with the improvement of the Nile recently made by the British. The Colorado River which flows south into the Gulf of California, and the Nile which flows north into the Mediterranean Sea, have points of similarity. One of the chief differences is artificial, and that is that the delta lands at the mouth of the Colorado river are cut off from the United States by the boundary of Mexico. In the United States are some good bottom lands, but the largest part is in Mexico. The public lands along the river have been temporarily withdrawn from disposal, and parties have been placed along the river to make preliminary surveys. The river issues from narrow canyons, but its floods sometimes spread out for several miles over wide valleys, again contracting in narrow canyons. It is possible to put dams at one point and another in these canyons.

In the construction of these large works a great many matters must be considered besides the cost and the methods of storage. Water for reclamation is obtained not wholly from surface streams, but occasionally from underground sources and by pumping. The carrying of water across depressions must also be accomplished, either by flumes or else by inverted siphons, so called; big pipes built to carry water under pressure. This requires elaborate planning and estimates of material to be used. The ditch must be given the right grade, for, if the slope is too gentle, sediment gathers and weeds grow in the top and choke it up; if too great, the water cuts out the soil. There is a nice adjustment of slopes to be observed at all times. The material for construction may be of earth, of stone, of concrete, of wood, or of iron. To put the right material in the

right place and at the right time requires great care and judgment.

The most substantial structure is perhaps very expensive at first, but it is not wise to plan a work of this kind at a minimum expense, for the ultimate cost of maintenance is more important than the first cost of construction. The cost of construction is to be paid by the landowners, but it is far better that they should pay a liberal amount at first in the ten annual installments than to have an inordinately great cost of maintenance.

It is to be noted from what has been said that the future of these reclamation projects is dependent largely upon the keeping of the forest areas in good condition. All of these rivers whose waters are to be utilized issue from forests. We are vitally interested in the preservation and proper control of the forest reserves. Much has been written of the theoretical influence of the forest upon the rivers, and it is evident that in the planning of these reclamation works it is to their advantage that the forest reserves be extended to take in as far as possible the catchment areas of the streams. This work of the Government is not a tentative experiment, and every condition must be kept as favorable as possible for the future maintenance of these great works.

THE APPLICATION AND POSSIBILITIES OF THE FEDERAL FOREST RESERVE POLICY

EDWARD T. ALLEN

Delivered before the Society March 26, 1903

The Acts of 1891 and 1897 authorized the President to set aside forest reserves and the Secretary of the Interior to manage them. The Act of 1897 left much to the Secretary's discretion, yet made certain stipulations, which, being statutory, can not be changed without Congressional action. On the whole it is not a bad law, but it has a few weaknesses which should be mentioned before we pass to its executions. Among these is the non-export provision. With a view to protecting the individual States, the Act forbids the use of reserve timber outside the State in which it grows; overlooking the fact that many States use so little timber that immense amounts of overmature or accidentally killed material, which is badly needed elsewhere, must be entirely lost for want of a market. This was one of the most serious mistakes made by Congress in the Act; but a graver one was the lieu land clause. This was intended to relieve settlers whose property was injured by arrested development, by allowing them to exchange their homesteads for land outside the reserves, but it resulted in wholesale trading of worthless railroad grant and logged-off land for valuable public domain.

While the Secretary of the Interior has final power in reserve matters, as long as he keeps within the law, the work is done by Division R of the General Land Office, so that actually the Commissioner of that office has great influence. Most matters not specially delegated to the Secretary by law need not go above the Commissioner. He, in turn, simply ratifies the decision of the Chief of Division R in matters which do not urgently require his attention. This

chief's time is taken up largely in planning the general administrative policy for the reserves, so the details of business between the Department and the public, as well as instructions to field officers, are conducted largely by clerks.

The field force consists of inspectors, superintendents, supervisors, and rangers, named in order of rank. The rangers do the patrol work, fire fighting, timber scaling, etc., their duties varying greatly with the character of the reserve. They generally receive $60 a month, although some are paid $75, and a very few, $90. Each reserve is managed by a supervisor to whom the rangers report, for the latter are not allowed to address the main office. Supervisors receive from $1,200 to about $2,500 a year, and certain expenses. Formerly each State had a superintendent, at $2,000 a year and expenses, who served no practical purpose, but the number of these has been reduced. The highest field officer is the inspector, who is supposed to see that neither the field force nor the office make mistakes. Formerly there was but one for the United States; for a time there have been two. Their pay has varied from $1,600 to $2,000, with a $3 per diem allowance for subsistence.

Since it is impracticable to describe at length the details of procedure in all reserve business, an outline of the method of allowing timber and grazing will indicate the general system. A purchaser of timber first applies to the supervisor, stating where and how much he wishes. A ranger, if not the supervisor in person, goes over the ground with him, explains the restrictions imposed by the Department, such as economical use of material, cleaning up the slash, etc., and estimates the yield. This estimate is the basis of the advance payment always required. If the applicant desires a certain quantity of timber, the size of tract is made to conform; if he wants all material on a certain area, it is equally necessary to know what the amount will be. The estimate, together with a map, forest description and rec-

ommendations which practically constitute a working plan, is forwarded to the Department, which decides whether to allow the sale. If it does, the applicant is notified to deposit a sum to cover cost of advertising, for public notice is given of the coming sale and anyone has a right to bid. The successful bidder is obliged to pay the purchase price in advance, to sign a definite contract embodying the method of cutting, and to give a bond to secure his performance of the contract. Unless there is good cause for extension, all timber must be removed within one year, the object of this being to prevent speculation.

Free use of timber by settlers, prospectors, and others not expected to buy, and privileges such as rights to build roads, ditches, and telephone lines, are granted after application and report much as in sale cases, the only difference being that there is no advertising or payment for the privilege.

The grazing capacity of each reserve is reported every fall by the local officers, and the Secretary decides whether cattle or sheep, or both, and how many, are to occupy it during the coming year. Applications for pasturage are received by the supervisor and, unless for less than 100 head of cattle owned by residents, in which case he can grant them, forwarded to the Department with his recommendation. When the applications aggregate a number greater than that allowed on the reserve, the supervisor devises a system of cutting from each until the allowance is reached.

These are but two of the many branches of reserve work. The officers have also to fight continual trespass of all kinds and secure settlement or the prosecution of offenders; to investigate frauds under the mining and land laws; to devise means of combatting fire and insect invasions; to report on proposed additions and eliminations; to report the location and character of all settlements and enterprises in the reserve; to enforce the State game laws; to scale tim-

ber and supervise the cuttings under free use and sale cases; and, above all, to ride the trails constantly during the dry season so that no fire can gain headway before it is discovered.

It is evident that to do all this successfully a forest officer should not only be intelligent, but have considerable experience if not technical training. Unfortunately the present system of recruiting the force does not secure such men. The superintendents have always been appointed entirely through political influence, without regard to fitness. Some have been fairly good men, but the majority were worse than incompetent. Until within the past year (1902) it has been the same with supervisors. They have included lawyers, doctors, editors, real estate dealers, postmasters, and even a professional cornet player. Some have been so dishonest and depraved that they disgraced the service; all have been technically disqualified, yet many are excellent men, and by intelligence, honesty and executive ability, make up for their lack of timber knowledge.

It has been the same with the ranger force. Bartenders, dive proprietors, superannuated ward politicians, and immature boys brought discredit on the service, which the few good men could not redeem. At first none of them pretended to do anything but loaf around camp and town.

This state of affairs has now improved to this extent: That bad men without "pull" are removed when found and good men are sought for appointment unless the place is desired by a man with "influence." In other words, merit has become a secondary consideration, whereas before it was no consideration at all. Yet this bad feature remains — the average supervisor dares not discipline, or try to discharge, an incompetent man having influence, so the Department, even if it would not support this attitude, does not learn of the man's delinquencies.

Finally, the salaries paid, in turn regulated by the ab-

surdly small appropriation, are not sufficient to attract good men. It cannot be expected that a good woodsman, who can always get $3 or more a day in a logging camp, will work for a short time in summer and furnish his own horse for $60 a month.

What I have said about the character of the men employed is not intended as a reflection on the appointing powers. It is to some degree the inevitable consequence in an institution whose personnel is controlled by politics.

I have said that the inadequate appropriation has prevented securing satisfactory men. Worse than that, it does not permit having enough men of any kind, for practically it provides for little more than an administrative force and leaves a nominal amount for execution. The Department provision for the office force of Division R does not suffice, so about $6,000 of the annual $300,000 appropriation must be used here in Washington. About $26,000 goes to superintendents, $90,000 to supervisors, and $20,000 to extra help on fires and other incidentals, making $142,000, or nearly half of the total, spent for service other than that of rangers. A year or two ago it cost $70 in supervision to get $100 worth of actual work. Now the proportion is perhaps $50 to $100. The fifty odd reserves contain about 61 million acres. The $300,000, with the Department office roll, gives about one-half of a cent an acre to protect the reserves, and the money actually spent in work by rangers is less than one-fourth of a cent an acre.

In the first four years there was little administrative system. The regulations for grazing, patrol, and timber management were drawn by men in Washington without any knowledge of field conditions and little of the subject in general. These rules were often impractical, and always hard to execute because lacking in detail. Timber sales and privilege cases were delayed months or years because there was no system for getting the information needed by

the Secretary before he could decide upon them, or for managing the cutting, if allowed. General instructions to officers were few and brief, and no one was able to advise his subordinates. The uncertainty of tenure and impossibility of promotion deterred good men from seeking ranger positions, even if they could command the necessary influence. Thus the force not only brought the service into public contempt, but prevented the office from accomplishing any reform in methods. In fact, the business began in the chaotic condition which might be expected in a new movement, and circumstances did not tend toward rapid improvement.

Things continued much in this way until a little over a year ago, when the Secretary realized the need of vigorous measures and placed competent men at the head of the work. The change was apparent almost immediately, and a year brought more improvement than had the previous three. The timber sale and privilege systems were revolutionized, and made simple business transactions. All hitherto vague and inadequate rules were improved, and explained in circulars. Supervisors were allowed to deal directly with the main office instead of having their business delayed by incompetent or dilatory superintendents. The latter were removed in many cases, in others made into local inspectors. The ranger service was graduated into $60, $75, and $90 positions, the higher ones to be filled chiefly by promotion. Candidates were required to show fitness for the place whenever politics could be ignored. An inspection service was established by which the field men were instructed, as well as the Department informed of local conditions.

The improvement was greater than would be thought possible in so short a time, and was recognized in all quarters. Not only did the office find it possible to do business more intelligently, but the field men welcomed a system by which they could do more satisfactory work. The public soon found it possible to secure its rights legally, and tres-

pass ceased to a great degree. In those reserves where the officers are willing to do good work, the troubles have greatly diminished and many former enemies of the reserve policy have become its friends. Early in this year (1903) there was another change in management, and, while it was not a complete return to first conditions, and improvement in details remains, the reserve administration is still very unsatisfactory as a whole. First of all, the appropriation will not permit efficiency, no matter how wise the plans, especially in so far as fire protection is concerned. The appointment system still leaves field work in incompetent hands. Aside from the dishonesty and neglect which might creep in under any system, perhaps no worse in this than in others, the fact remains that the system does not secure timbermen, and placing a reserve in the hands of a doctor or an editor is like setting a shoemaker to run an electric plant. This is fully realized by the Department; but, unable to remedy it by changing the character of the field force, it is obliged to allow the latter no discretion or authority, and to have it mechanically execute instructions from the central office. These instructions again, both as to details and general policy, emanate from office men with small knowledge of forestry, lumbering, grazing, or even field conditions. There you have the system: An office force without knowledge of the reserves, managing them with no information other than what comes from the very men admitted to be too unreliable to decide anything themselves! And I do not say this to criticise the office force, for I think the efficiency it has attained under such a system is remarkable.

Furthermore, both office and field forces are continually hampered by lack of power to enforce their orders. There is no code of forest laws. There are federal statutes prescribing penalties for stealing timber or setting fire on the public domain, but they are inadequate in themselves and

have no special application on reserves. The Secretary can make regulations, but they are legal only in so far as the Act of 1897 gives him power, and this is an unsettled question. Federal judges in several of the western States have ruled that infringement of his grazing regulations is not criminal; consequently there is no redress, since civil suit for damage would produce no results. In many parts of the West there is no means of preventing wholesale sheeping except injunction, which is frequently ineffective.

The general mining laws apply on reserves without change; so do the land laws on claims located before the withdrawal. This makes incalculable trouble, for in many reserves timber is taken by wholesale under cover of mineral and homestead locations. The legal requirements for proof are decided by the local land offices, and the reserve officials can only protest against the issuance of a patent and appeal with no certainty of success. It is still harder to stop the use of timber from unpatented claims, for then the only recourse is trespass suit under laws favoring the settler and miner, and in courts often sympathizing with the defendent if not actively hostile to the reserves.

If a forest officer reports a trespass in a reserve, the case is quite likely to be turned over to a special agent of a division in the Land Office which has nothing to do with reserves. There is always rivalry, usually hostility, between these divisions and it is generally a point of honor for them to disagree. If the case is decided upon the special agent's report, differing from that of the forest officer, the latter's power in that region is lost.

Forest officers can not make arrests. If they find a man stealing timber or setting fires they can only report him to the supervisor, who goes to a United States Commissioner, perhaps 100 miles away, and gets a warrant. This is given to a marshal who in time goes out to look for the offender.

Then there is the hostility of the people to be encountered at every move. Often people in and around reserves are suspicious and antagonistic and fight every act of the officers. This, after all, is the most serious feature of the problem and demands more thoughtful attention than it usually receives. It is commonly supposed to be due to misunderstanding of the Government's policy — that only a little explanation is necessary to remove it.

It is true that the Government's policy is not understood. And why? Because there is no policy in application to understand. The people of the West judge by what they see. They see incompetent, perhaps dishonest men placed on the reserves for political service. They judge from that that the reserves were created to furnish patronage. In another locality, where there is a railroad grant, they see the lieu-land law turned into a scheme for wholesale trading of worthless land for timber, robbing both the Government and the people. There they conclude that the reserves were created by railroad legislation and for no other purpose.

They see numerous restrictions, which appear to them unjust hardships, imposed upon settlers and miners. These restrictions have an object and if it were explained they would see it, but no one explains it. The local officers are the ones who should illustrate and preach the policy, but they can not because they do not know it. Nobody ever told them. Three times out of five they have the same point of view as the people, but enforce the laws because they are paid to, not because they believe in or understand them.

Next, the people judge from the lack of adherence to the policy they do know of. They know that trespass is forbidden, yet they see that rich and powerful trespassers seldom pay any penalty. They read that the Geological Survey, the Bureau of Forestry, and perhaps the local officers, have reported that sheep are absolutely fatal to a cer-

tain region, yet the sheep go in with permits. They hear of a proposed addition or elimination for some reserve and that the Bureau, the Survey, the forest officers, and the special agents of the Land Office all have different opinions of the case. Each of these branches is the Government in their eyes. Then possibly the action taken contradicts all five. What can they make of the Government's policy? Then again, they see that Congress — also the Government — often goes back entirely on the executive branches. We tell them that the Government does not take their timber from them to let it stand and waste, but to manage it wisely for their own good. Yet they see the bug-killed timber of the Black Hills, the diseased pine in Idaho, and the immense fire-killed tracts in Washington, being lost for all time because Congress will not repeal the non-export law.

We tell them that the reserves do not prevent development of legitimate industries — that a miner has only to apply for timber, or an irrigation company for right of way, and permission will be granted. Their application is held up until they abandon the enterprise, or go ahead without permission and find themselves sued for trespass; and we explain either that the officer who examined their case was incompetent, or that Congress does not grant men enough to do such work. Is it any wonder that they misunderstand the policy and are dissatisfied?

Coming to suggesting reforms; of course a merit system of securing men is all important. The ideal may never be reached, but there can at least be an improvement. Managers of timber reserves should be lumbermen and foresters. Managers of watershed reserves should know something of grazing, something of hydrography, and a great deal about improving the forest. Western men and local men will always be more valuable, not only because they enlist confidence, but because they can sympathize with local needs

and understand local misrepresentations. When there are better men, men who can be trusted, they can be given freer hand, and the inevitable mistakes of too-detailed, long-range management will be avoided. There must be a definite policy, broad perhaps, but tangible and capable of explanation and illustration. The Government must study the rights and needs of the people more, both in creating and administering reserves, and, by getting their cooperation through friendship, make them help and not oppose the work.

It seems hard to overestimate the possibilities of the reserves, especially when we bear in mind that they are to endure as long as the nation. Their ultimate future importance in protecting the water supply of cities and irrigable regions can be comprehended to some extent by considering the magnitude of the irrigation plans outlined by the Geological Survey, and remembering that without forest reserves these plans will be almost useless. No less necessary is the preservation of a timber supply. Already mining is one of the great industries of the West, yet it has really hardly commenced. Fifty or a hundred years will see a hundred big mines to every one now existing, and all will depend for success on a local supply of water and fuel.

When the Southern and Lake States pine is gone, the whole East will draw heavily upon the Pacific Coast reserves, which, having heavy rainfall and a warm climate, produce merchantable timber in a few years. Then the reserves will be managed like farms, producing revenue for the Government, supplying lumber to the treeless eastern States, and sustaining a great lumber industry in the States in which they lie. Without reserves the western timber would soon be gone, the mills and camps abandoned, almost every industry of the western States affected; with them prosperity will endure indefinitely.

This is the ideal, and it is perfectly possible; but I con-

sider it by no means assured. If the present dissatisfaction in the West is aggravated by unwise administration and ill considered creation of new reserves, there may be a rebellion ending even in the abolishing of the reserves entirely.

The institution will never be successful as long as it is maintained without the sympathy of the people, and they will have neither sympathy nor confidence until they see a strong field force, not too closely restricted in details, and an undivided central management having knowledge of western conditions and backed by statutes enforcing its authority.

THE DISPOSAL OF PUBLIC LANDS

GEORGE W. WOODRUFF

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When a private individual becomes the possessor of a great landed estate, he proceeds to manage it on business principles, which as I take it, are popularly and correctly conceived to be those which are likely to bring to the owner the greatest or best return. By return we do not mean merely money and allied tangible commodities. We mean any and every thing which seems to the person interested, good or desirable. Thus the great private landowner will sell portions of his estate for a nominal sum or even give them away, because he conceives that a partial settlement of his land, with little or no money return, will, by enhancing the value of the remaining part, prove a better business plan than holding all for higher prices, which may not be realized for years. He may give sites and building material and money for churches, schools, and public buildings, because he actually believes that a high moral and intellectual tone in a community will draw a class to his locality with more money to expend for that land and fuel and building material. Also, for his own pleasure, he may set aside the choicest part of his estate as a park and pleasure ground for himself, and, instead of getting money therefrom, actually expend great sums in beautifying and protecting it from invasion. In short, the private landholder may manage and dispose of his land: First, by gift in order to enhance the value of the remaining part; second, by gift in order to be helpful to individuals and communities; third, by sale at increasing prices in order to continue settlement and secure ready money; fourth, by appropriating and improving choice parts of his land in order to keep the same for his own pleasure; fifth, by using

in a business way the lands undisposed of in order to get a money return therefrom.

The United States, upon acquiring independence, became a great landholder, and, by subsequent strokes of business policy, increased that holding to an area of tremendous extent. It was most natural that Congress, as agent plenipotentiary for the people, should have commenced to follow, consciously or unconsciously, much the same course as that pursued by the private landholder. Thus, in the early management of the public domain, it was probably good business policy to sell land as fast as possible for a low price to any and all buyers. Speculative purchasers would naturally strive, from purely business motives, to induce settlement, and therefore by public sale and private entry Congress secured the cooperation of hundreds of good business men to help out the desirable object of rapid settlement.

However, the dispositon of the public domain, which at first follows the early stages of private management, ultimately departs from the parallel in this respect, that it always has been and always will continue to be the means to an end, instead of the real source of a business return to the Government. The private owner looks forward to the time when the settlement and use of land already disposed of by him will cause his remaining property to be more valuable, and expects to reap his profits from his later sales or leases. The Government, on the contrary, grows more and more desirous of giving away its land to actual and desirable settlers, and the millions of dollars which have come into the National treasury from public land sales do not represent the kind of return which, as a business venture, Congress should have been and was looking for. Fortunately for our country its wealth does not depend, as does that of the private owner, on the enhancement in value of land not yet disposed of; but as the land

already sold doubles, trebles, quadruples, and increases in value up to one hundred fold in rural districts and perhaps a million fold in cities, just that rapidly does the wealth and prosperity of the country increase.

Inertia is a law not only of matter but of mental action. Congress began to have glimmerings of the good business policy of discontinuing sales to speculators and of disposing of the land to actual settlers only, as early as the very beginning of the last century, but until 1891 it was not able to bring to bear counter forces of sufficient strength to overcome the habit of selling ad libitum. In 1841 it foreshadowed the idea of actual settlement as a business return for land surrendered, by passing the preemption law requiring such settlement. In 1862 this idea found more definite voice in the Homestead Act, marred only by its commutation clause.

It may be worth while to moralize briefly on the business reason for discontinuing sale in general and confining entry of public land to actual settlers. Some might ask, Why not continue to let the clear-sighted, level-headed business men purchase the land, and, by their energy, planning ability and capital, bring it to a profitable use at an earlier date than could be hoped for by putting it into the hands of many owners, notable neither for their brains nor their resources? Surely, they say, there will be greater production, less waste and more wealth from first-class business management than from great division of ownership. The reply is, that whereas we admit the value of wealth and prosperity, and would undoubtedly prefer to see the country very wealthy with but a small number of landholding citizens, rather than in great destitution with all citizens equally poor, we nevertheless recognize the fact that it is a decided good to escape either extreme. The owners of private property might be said to form the fly wheel which governs and saves from self-destruction the huge, hetero-

geneous, economic machinery of our country. This wheel must have a size and weight commensurate with the increase in power and speed and magnitude of our national enginery.

That there is need to dispose of the remaining public land to settlers only, is evidenced by the efforts, made for many years and culminating in 1891 in the repeal of laws permitting the general sale of public land, securing it by pretended timber culture, or purchasing it by the easily perverted preemption laws. Since that time there has not passed a year but the wisest heads have advised the further repeal of all laws which do not dispose of public land for the one purpose of actual settlement by homemakers.

This brings us to the consideration of the laws now in force and their abuse, basing the idea of abuse principally upon such fraud as permits individuals to obtain possession of large tracts for speculative purposes.

The oldest act now in general force is that of September 28, 1850, granting swamp lands to States for reclamation purposes. No act shows better than this one how hard it is for a State to administer public land for the best good of the people. There is little doubt that more than half the land patented to States, as too swampy to admit of cultivation, has been secured fraudulently for the advantage of private individuals having political pull with State officials. Much of this land is very valuable, being in rich bottoms and along creeks and often having heavy timber on it. The States usually sell it at a minimum price, in any quantities, to favored individuals who persuasively draw the attention of State officials to the swampy condition of certain desirable land. Suppose the desired tract is along some creek. The wouldbe purchaser rolls or fells some logs into the creek, and behold the swampy and overflowed condition of the land at that point. Witnesses make their affidavits with a clear conscience, for did they not see the overflowed

condition with their own eyes? Or when such a simple method as this can not be used, men have been known to put a boat on a wagon, and, having been hauled across the desired land seated in the boat, are able to prove its overflowed condition beyond peradventure by making affidavit that they crossed the entire tract in a boat.

The homestead law of 1862 was next, and it is the one law, barring its commutation clause, which is undoubtedly good.

In 1877 the Desert Land Act was passed, ostensibly to assist in irrigating and reclaiming arid lands; but the majority of the Senate Committee on Public Lands of the last Congress states definitely as follows: "This act was not created for the benefit of farmers wishing to build homes in the far West, but was placed on the statute books, in the first instance, to enable a few wealthy men to acquire vast bodies of land in California." It seemed a hardship to permit a man to spend money in attempting to reclaim desert land and then, because he was unable to continue his reclamation work for reasons beyond his control, make him lose all he had invested by not permitting him to assign his partially perfected claim. Believing this, Congress gave the desert land claimant a right to assign. It is this assignability which is the weak point of the law. A rich man can induce scores of persons to make desert land entries with no bona fide intention of continuing and acquiring title. These entrymen assign to the capitalist, and he thus procures for himself an immense tract of grazing land. As in the case of overflowed land, so in the desert; the witness, to prove compliance with the requirements of the statute, has a tender conscience. He wants to swear that he has seen the claimant conduct water upon the land. Therefore he watches while a bucket of water is lavishly poured on the thirsty soil, and goes merrily away to make his affidavit. Personally, I can see no greater hardship in

forbidding assignment of unperfected desert land claims than a similar prohibition in homestead entry. If his improvements are of any value, the party who made the original entry can secure from some other eligible settler a reasonable return for judicious relinquishment; if his choice of locality were so bad that nobody else wants his claim, he should suffer the consequences of bad judgment like any other man.

Next in order come the two acts of June 3, 1878, both of especial interest to foresters because they deal with timber on the public domain. The first of these acts is the one permitting any and everybody (The actual words are: "Citizens of the United States and other persons") to cut and remove timber and wood from any mineral lands in any mineral district of the United States for almost any conceivable purpose. The exact words are, "for building, agricultural, mining, and other domestic purposes." The very looseness of the wording of this law has caused it to be used as the cover for tremendous timber steals. The Secretary of the Interior has ruled that no trees less than 8 inches in diameter may be cut under the terms of this act, but it has been impossible to keep even a pretence of enough inspectors or agents to supervise cutting, and no attention has been paid to the Secretary's regulations or to the actual mineral status of land on which desirable timber is standing. The commission appointed in 1896 by the National Academy of Sciences to investigate the public domain question, says: "To this act can be traced the destruction of immense forests in Colorado, Nevada, Arizona, and Montana, and wherever it can be made applicable the evil results which have followed its passage are plainly visible."

Before mentioning the Timber and Stone Act, I will call attention to one specific kind of fraud due to special regulations. Owing to the rule granting permits to cut dead

and down timber, there are undoubtedly cases where large areas were intentionally burned year after year, in order to kill the timber and thus get permission to cut the same for nothing. Some railroad companies have followed the tracks of such fires, building, from year to year, for that and no other reason. Similarly, sawmills are established and a supply of material provided for them by systematic burning.

The other act of June 3, 1878, was the Timber and Stone Act. This was limited to certain States and Territories at first, but was extended to all public land States in 1892.

This law, being the last one, except the Desert Land Act, by which speculators could quickly get hold of large tracts of public land, and being the only one, except lieu selection, by which they could obtain title to valuable land, has been worked over-time during the last decade, and it is to be sincerely hoped that the prompt preliminary report of the Public Lands Commission appointed by President Roosevelt last fall will bring about the repeal of this harmful law before the close of the Fifty-eighth Congress. The law is baneful for two reasons: First, Because by fraud (permitted or unindictable under the terms of the act) large areas of our remaining timberland are passing into the hands of a few persons instead of becoming the abiding place of numerous thrifty families, as we all agree should be its use if possible; second, Because we have arrived at the stage in our national development when we have discovered that we had deferred too long the forms of business management which correspond to the fourth and fifth items in our outline of a proper course of action for a private owner; viz., the setting aside, protection, and development of permanent parks for the value of their products and the pleasure of their healthful beauty; and the sensible management, from a business standpoint, of that part of the public estate which, for any reason, is withheld more or less permanently from disposition to private owners.

Now it is a well-understood fact that, just as Congress rightfully diverges from the plans of the private land manipulator by striving to grant the public domain for a merely nominal money return, so Congress also abstains, as far as possible, from carrying on a land business with the public land kept back from disposal. This principle of leaving private business to the enterprise of private persons or corporations seems to be best exemplified by its occasional exceptions. The postal system and the management of forest reserves are examples.

The hand to mouth days of the American people are long since past. Congress has properly recognized the business right to set aside great national parks in order to cherish them for their beauty and pleasure-producing power and as objects of proper national pride and glory.

Somewhat allied to the national parks in sentiment, but not directly akin to them, logically viewed from a business standpoint, are our national forest reserves. They are the only part of the public domain which Congress contemplates setting aside for permanent public business use. The reasons are familiar to all: Just as we were afraid to trust private individuals with our mails, we were forced to the conclusion that private owners of timber would neither be thoughtful for future generations nor thriftful for the present one. This was evidenced by the unanimity with which private owners of forests slashed off the timber as soon as they could find a market for it, and left the denuded land to its fate unless they were able to get some small price for it as agricultural land.

The evils and dangers of the prodigal course of private owners led to early and frequent efforts to have Congress take action. After years of such effort, success came in the form of a small section tacked on to the end of the act of March 3, 1891. The result of this action is the forest reserves, present and future. Right here is where actual busi-

ness management became necessary. The act would have been inexcusable, if it had taken the forest reserves with all their resources of wood, stone, water, power, health and pleasure *from* the people. The only excuse is that they are taken *for* the people, and will be administered in a business way to that end. They belong to all the people and it would be unfair to surrender their resources and advantages to a favored few, without exacting a reasonable return for the good of all.

Meanwhile, however, the change of conditions in our country due to increase of population and to more than proportionate decrease of timber supply, has brought home the necessity, in order to lessen fraud and be fair to the people at large, of arranging for the sale of timber on public lands which are yet neither withdrawn for forest reserves nor sufficiently valuable for agriculture to be taken under the homestead law. At present there is no power in the Secretary of the Interior to sell any timber on such unreserved land. He is obliged to let free timber be cut almost ad libitum from mineral land under the Act of 1878; and, under the Act of 1891, he is in hardly a better condition with regard to non-mineral land. The people must have timber. They see it very poorly guarded in large quantities on unreserved public land. They know Congress has arranged to give them free use, but not the right to buy. What wonder then that they cut without permits, or that it is hard to get a jury to convict except in flagrant cases, or that the Secretary of the Interior is obliged to yield to most requests for the free right to cut. The Public Lands Commission, in which we have such a deep interest, acted promptly toward helping out this state of affairs. It has already had introduced a bill prescribing rules for the equitable sale of timber and for the manner of cutting and removing it; also for disposing of tops and other refuse in such a way that the land will have a chance to reforest itself.

SILVICULTURE APPLIED TO VIRGIN FOREST CONDITIONS

ALFRED GASKILL

Delivered before the Society March 12, 1903

In attempting to solve a set of problems so many-sided as that which belongs to the forests of the United States it is inevitable that difficulties be encountered, yet I have been led to question whether the instruction in silviculture that we have hitherto had is not seriously faulty, or at least insufficient for the kind of work that we must do. Season after season we go into the woods and find that much of the meaning of what we see escapes us. *Why* does an island of hardwoods appear in a great forest of conifers? *Why* are the boundaries of white pine, red pine, jack pine, often so clearly marked? and so on.

We have learned to accept the principle of tolerance as a key to many mysteries, but what is the *law* that makes it applicable to any species and every situation?

In studying silviculture from the textbooks one soon comes to the conclusion that the rules for re-establishing forests and for managing even-aged forests, pure or composed of a few species, do not apply to the great complexes that must be treated in this country, nor to those areas within which a deficiency of moisture makes tree-growth difficult. One is impressed with the lack of a *science* of silviculture, a *system* broad enough and deep enough to fit anywhere. European foresters have done well in many cases it is true, but their successes have been greatest where their task was simply to establish forests, or to care for existing ones, under extremely favorable economic and climatic conditions. The doubtful value of much of the work of their experiment stations, and the partial or total failure of many attempts at forestation, point to some seri-

ous fault in their system. Without disparaging the work of the Europeans, the greater part of what they have done is comparable to the task of perpetuating the forest in the Black Hills, or re-establishing the white pine in Massachusetts; and that is chiefly management, not silviculture. The choice of species for plantations in the great West, and the theory that shall govern reproduction cuttings in a mixed forest, depend upon more than rules of practice deduced from experience in a region so uniform in climate and with so few native tree species as central Europe.

It is of course true that with the development of forestry in this country we shall learn to adapt our practice to local conditions, but the danger that seems to me so great is that with a faulty method we shall simply repeat the errors of the Europeans and do little to further the establishment of a real system of silviculture.

The conviction that the theory of silviculture as we had it was wrong — in fact, scarcely a theory at all — was reached after I had gone through most of the textbooks and had had experience of much of the practice in central Europe. It then occurred to me that the value of the teaching of the European schools might be tested, in a way, by observing how the men trained in them applied their knowledge in places remote from the industrial centers and where the conditions were somewhat similar to ours. This was fair, because Schlich and most other writers claim that their principles are of universal application.

In pursuance of this plan the first place visited was the famous Karst region, at the head of the Adriatic. The whole country was originally heavily wooded, but was stripped of its forests to help build Venice, and the land given over to fires, grazing, and every form of maltreatment. The result is that for a hundred square miles or more the rounded limestone hills are absolutely bare and constitute the classic type of forest destruction. But the condition

of the region is not the point of present interest, nor what produced it. Forty years or so ago the Austrian government undertook the task of reforesting the area, partly because unproductive ground was a reproach, partly to give employment to the people of the region, who had become desperately poor through the exhaustion of their farm and grazing lands, partly because it was thought that the trees would shelter Trieste and other cities from the "bora," a strong, cold, winter wind that causes much distress. In any view the effort was praiseworthy; but how was the task undertaken? Here was a region with sufficient rainfall but subject to periods of drouth summer and winter; with the soil in many situations so far gone that not a blade of grass could grow, with nothing but the clefts in the rocks to hold tree roots; with a degree of radiation from the white limestone that burnt things in the summer; and with the certainty of a strong northeast wind during a good part of the winter. The conditions were as adverse as those that now confront our foresters in Southern California, except that the government was prepared to spend the necessary money; yet, in the face of all, much time and money has been wasted in experimenting with species that were foredoomed to failure. The European larch is a good tree, but it will not grow where soil and air are often dry, nor where the "bora" winds make whips of its light, flexible branches. Similarly, the spruce has failed, manifestly because the locality is not humid enough and the rocks give little anchorage for its shallow, wide-spreading root system. Other trees have likewise proved unfit, although fortunately by far the greater part of the plantations have been made with the native black pine (*Pinus austriaca*), and are doing well in the majority of cases.

About a hundred miles eastward from the Karst, in the heart of Bosnia, is a considerable area of virgin forest which has survived until the present because of its inaccessibility

and the disturbed condition of the country until the Austrians assumed control of it. It is considerably higher than the Karst, but the geology and the topography are essentially the same. The forest, of spruce and fir, with some maple, beech, elm, fortunately belongs to the government, which, in lumbering it, is extremely careful that enough trees shall be left to effectually shield the ground and provide for regeneration. In this instance there are no experiments: with the lesson of the Karst before them, the forest officers do nothing that can in any way weaken the power of the forest to maintain itself, and they frequently help out nature by planting up the openings, always with the native spruce.

On the ancient Tartar plains — the steppes of middle Hungary — is another interesting situation. The land is alluvial and very variable, so that under the high winds that prevail there the lighter soils dry out easily and are set in motion. On these poor soils something over two hundred thousand acres have been planted to our black locust with highly satisfactory results. The tree grows rapidly, and thus far has developed no enemies of importance. Whether any part of the land can be recovered for agriculture by its means, as is hoped, remains to be seen: the oldest plantations are only about thirty-five years old, and though the first crop has been cut it will require several rotations at least before the soil will be sufficiently strengthened to warrant the removal of the trees. There can be nothing but praise for this work, which is providing employment for a dense population, wood for their necessities, and adding wealth to the nation.

With the planting of the locust, experiments with other trees have been carried on: this in the main is good, because here and there are patches of soil apparently rich enough to bear other trees, or, on the other hand, so poor that even the locust will not grow, yet the want of proper silvi-

cultural training leads the foresters to plant such exacting species as silver poplar, white oak, larch, spruce, and walnut.

About a hundred miles south of the locust plantations, on the inundated bottoms of the Danube, is the great hardwood forest whence comes Slavonian oak. The land is rich, like the best in our Mississippi Valley, and being periodically submerged cannot be cultivated. The foresters, however, have found an admirable way to make it productive, and for forty years they have been growing oak with great success. The plan is to cut out of the forest all the less valuable trees, elm, maple, etc., old and young, and leave the oak standing five years to seed the ground. It almost always succeeds, although of course there is some mixture of the other species through their winged seeds. This system of management is admirably suited to many localities in the United States, notably the Yazoo delta, although the greater diversity of species, many of them of little value, and the relatively smaller quantity of oak to serve as seed trees, will make its operation here somewhat more difficult.

Another example of mistaken silviculture, though regular foresters are not responsible for it, is found in the eucalyptus plantations near Rome. From what has been done there the impression has gone abroad that eucalyptus trees will overcome malaria, that they are deep-rooted trees, and that they will grow almost anywhere. All of these so-called facts are mistakes, in so far as the trees at Tre Fontane are concerned, for few of them are in the swamps; their roots are so shallow that many of them are overthrown, though that may be due to the thin soil in which they grew; and the eucalyptus is so nearly a tropical tree that it suffers severely from frost in the latitude of Rome. These are all points which the European foresters should have brought out, for even if they did not plant the trees, they have repeatedly referred to them and quoted the statements of the monks who own and manage the groves.

On the opposite side of Europe is another example of mistaken silviculture, this time by the Danes, who in many ways are worthy to rank with the best foresters. Some years ago the people were filled with the laudable desire to forest the waste lands that lie at the north of the little kingdom. They are extremely sandy, largely covered with heath plants, and under the influence of strong sea winds. Moreover, the sand rests in many places on a stratum of hardpan, often not more than eighteen inches below the surface. Under these conditions the choice of tree species would seem to be limited to a few of the least exacting and most hardy, yet spruce, oak, and other trees requiring good soil and a favorable climate have been planted, and some of the foresters announce their determination to grow spruce and no other, in spite of the fact that most of the plantations, some of them ten years old, show the want of success that might have been expected.

From the foregoing, my argument will be sufficiently clear, I think; namely, that European foresters have not developed a true system or science of silviculture capable of being applied to virgin conditions or to all conditions; for laws they substitute empirical rules; for wide observation and systematic study, a series of experiments whose aim and purpose are often obscured. Let us have experiments by all means, but let them be instituted to prove or disprove a reasoned conclusion, or at least a plausible theory.

So much for the negative statement. The positive, though much more important, may be given in a few words. Silviculture, to be worthy the name of science, must be coherent, logical, and capable of interpretation by precise laws. It is not enough to observe, for instance, that this tree is more or less tolerant than that one; we should try to find some measure of absolute values, or at least to know whether the relation between the two species

is a constant one or whether it varies with the locality. Having observed that it does vary with the situation, the question then is, What is the law that governs? If that be known, the contradictory and puzzling tables of relative tolerance published in the textbooks may be understood as expressing the limited field of observation of the author. Similarly, are there not laws that account for the notable variability in the root-systems of trees of the same species? Is there not a reason for the regular or periodical fruiting of certain trees that if known could be turned to account?

Some of you will recognize in this the teaching of Professor Mayr of Munich, and I thankfully acknowledge the helpfulness of his theory of the optimum. That is, in brief, that each genus, or in some respects each species, reaches its best development under a certain sum of conditions, soil, climate, etc., which he calls the optimum, and that the species varies according to definite laws whenever it is found under different conditions of heat, soil, moisture, or association. But though Professor Mayr has pointed out a new way, the great field of investigation is open. Trees properly studied in their native places will yield more of value regarding their fitness for being planted elsewhere than any amount of experiments, and at the same time one may hope to learn much regarding their all-important fruiting qualities, their power of accommodation to various soils and climates, and, above all, the relations of the various species to one another. This involves much more than a familiarity with the trees from the botanical or dendrological standpoint; the successful forester must study tree-geography as well, and he must have besides a good knowledge of climatology and be able to apply it at every step in his forest work. Only by such a course can the misleading instruction of the textbooks be counteracted. To how much of the United States, for instance, can you apply the common statement that "an east wind is dry, a west wind is moist?"

It is true enough for central Europe, but to be of universal application the rule must say "a land wind is dry, a sea wind is moist."

Unless these things be done and our teaching and practice be based upon general laws, American silviculture will be no more universal than German, or French, or Austrian silviculture; it will differ in details from each and it will lack those broad principles which alone can make it applicable to the manifold problems that are beginning to confront us.

OBJECTIONS TO THE FOREST RESERVES IN NORTHERN CALIFORNIA

ALBERT F. POTTER

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In the examination of the proposed forest reserves of Northern California, we found that the sentiment of the people residing in the counties within which the reserves were located was largely in opposition to their creation.

Some of these objections were based upon the assumption that all of the withdrawn lands were to be included in the reserves, regardless of their character or ownership, and others upon a misunderstanding of the policy of the Government and of the rules and regulations for the management of forest reserves.

As these questions were answered and explained, the fears of the people were allayed, and sentiment in favor of the reserves gradually increased.

Some of the objections seem well-founded, and a modification of forest reserve rules will be necessary to meet the special condition which we find existing there.

The ten most common objections to the proposed reserves have been arranged in the order of their importance as presented by the people. They are:

1. "That large areas of land now owned by the Southern Pacific Railroad Company, and unsuited for forest reserves, have been included within the withdrawals; that the creation of the proposed forest reserves will permit the Railroad Company to exchange these comparatively worthless lands for valuable lands elsewhere, and that the surrender of such lands to the Government will injure the counties by loss of taxes paid upon them."

One of the first objects of the examination of these lands by the Bureau of Forestry was to ascertain whether or not

they were of such character as to be valuable for forest reserve purposes, so that only those portions of the withdrawn lands which were of real value for such purposes would be included within the reserves recommended.

Where the lands were largely alienated, as in the proposed Mt. Shasta Reserve, special care was taken to exclude lands of doubtful character as to their forest value, and immediately upon the completion of the field examination, the elimination of eight and one-half townships, or 196,000 acres, was recommended, and these lands have since been released and restored to the public domain.

The people, as a rule, in estimating the value of land for forest reserve purposes are apt to consider only its present timber crop, while in many cases lands temporarily denuded of their timber may be very valuable for forest reserve purposes, as the reserves are for the future benefit of the people as well as for their present use. Lands which may be temporarily denuded, but which are capable of producing a valuable timber crop, may be of great value for forest reserves. Many of the slopes on the watersheds of streams which are or may be used for irrigation are often covered with only a scrubby growth of trees, and sometimes with only brush. The protection of these areas from damage by fire or other causes is of importance for the regulation of the water flow. Where large bodies of these low-grade timber or brush lands owned by railroad companies or others are included in a withdrawal for a forest reserve, it is the policy of the Government, as shown by its dealings with the Santa Fe Railroad Company in Arizona, to exchange for lands of equal value, and such reserves will not be created until an equitable basis of exchange has been agreed upon.

The future benefit to the country from the proper care of the lands will largely compensate for the present loss in taxes.

If a provision could be made by which a small part

of the money derived from the sale of timber in forest reserves would go to the public school fund of the State or County in which the timber is cut, it would help to make up for the loss in taxes on surrendered land, and cause the people to feel that they were to receive an immediate benefit from the reserve.

2. "That large owners of timber lands will denude their lands and then exchange them for valuable timber lands elsewhere, and that here again the counties will lose the revenue in taxes."

In framing the present law allowing the unrestricted exchange of forest reserve lands, Congress undoubtedly had the interests of the homestead settler foremost in mind and did not anticipate the opportunity it would offer for speculation. That its practical working has been detrimental to the best interests of the people I think is the opinion of the large majority of the friends of forest reserves, and repeated attempts have been made to limit the exchange to lands of equal value.

There are at present before Congress several bills having this object in view, and it is quite likely some modification of the law will be made. Even if this should fail, the opportunity for taking up timber lands is fast disappearing, as all of the large bodies of public timber land are being included in the new forest reserves.

In Northern California, many of the lumbermen and large owners of timber now realize that the natural conditions there are very favorable for practical forestry, also that timber lands are becoming scarce elsewhere, and they are not only holding on to their cut over lands, but in some cases have redeemed cut over lands which had been allowed to revert to the State for delinquent taxes.

3. "That the mining interests will be injured and mineral development retarded by reason of difficulty in getting permits promptly."

Much of the opposition of the miners was founded upon a misunderstanding of the rules and regulations. It was quite generally believed that prospecting and the location of mining claims would not be allowed, and also that the regulations under which timber could be obtained would be so stringent as to practically prohibit its use. When it was explained that this was not the case, and that prospecting and the location of mining claims would not be interfered with, and that the regulations provided a means for the purchase of timber at a stumpage value where needed in large quantities, as well as for its free use, and that the general policy for the future would be to modify the regulations when local conditions warranted such action, the immediate change in the sentiment of the miners was in most cases astonishing.

Another very important point which met the approval of the miners was that the creation of a forest reserve would protect from location by timber speculators and scrippers, lands which might not now be considered valuable for mineral, but which by improved methods of working and development might be so in the future, and could then be located under the mining laws. There is considerable complaint among the miners that large areas of such lands are being taken by timber locators and speculators and they have asked for a reclassification of the lands by the Government. The creation of a forest reserve would at once accomplish the object they seek. As all of these matters were better understood, the opposition from the miners rapidly disappeared.

4. "That live stock interests will be injured by the restrictions upon grazing within the forest reserves."

The opposition of stockmen is based largely upon the supposition that the regulations for Northern California reserves will be the same as for the reserves in the southern part of the State, and as conditions are entirely different in

the two sections, they feel that such restrictions would be unjust. Here again the importance of a full investigation of local conditions and the effect which the creation of forest reserves will have upon the people is forcibly shown. We have found in our examination that the prosperity of several of the Northern California counties depends largely upon the live stock industry. Almost the entire summer range is included within the proposed reserves, and the exclusion of live stock would mean disaster. It is the policy of the Government to utilize the forage products of the reserves under such restrictions as will insure the permanent value of the pasture lands, and there is no intention, especially in the creation of new reserves, to entirely exclude live stock. It is the unanimous opinion of the men who examined the proposed California reserves that the damage to the forest by grazing of live stock is in general not serious, and that a liberal number of stock can safely be allowed upon the reserves, provided the stockmen will obey the rules regarding fires.

The mountain ranges of California have in past years been much more heavily stocked than at present. The maximum limit to the number of sheep seems to have been reached in 1876 when the output of wool was 56,000,000 pounds. The result of overstocking was the same here as elsewhere: a sudden decrease in the carrying capacity of the range and serious losses to the stockmen. The present annual wool crop is about 26,000,000 pounds. The stockmen have profited by the lessons of the past and now realize that a proper control of the range is necessary for the continued prosperity of their business. When the policy of the Government was explained and the stockmen assured that their interests would be given proper consideration, and that sudden and radical changes would be avoided, the opposition to the creation of the reserves was generally modified.

In some portions of California, the stockmen own their entire winter ranges, and own enough land in the mountains to control their summer ranges pretty well. These men, as a rule, feel that they would prefer to let well enough alone, and although under the regulations they would be entitled to the use of these ranges if included in a forest reserve, they prefer not to take any chances.

There are also many bands of sheep owned and wintered in Nevada which cross the line into California for summer range. As the standing rules would exclude these, their owners are opposed to the reserves. The facts seem to be that there is a surplus of winter range in Nevada, and a scarcity of summer range. These men have been engaged in the business for many years. They lease lands from the Railroad Company, pay the county license fee of five cents per head, and have had the continued use of this summer range. The conditions seem to warrant a modification of the rules and the granting of permits for a certain number of these bands.

Again, it has been the custom of some of the residents of the Sacramento Valley to purchase bands of sheep in southern Oregon during the early spring, and trail them through the mountains during the summer, stopping en route wherever good feed was found and arriving in the valley in the latter part of the season with fat sheep for the market. This sort of grazing is detrimental to the best interests of the resident rancher, and should not be allowed unless there is a surplus of feed which would otherwise be wasted.

As all of these matters are adjusted on a practical basis, the opposition of the stockmen will disappear, and their hearty support be given to the reserves.

5. "That a large portion of the withdrawn land will grow fruit trees after the timber is removed, and would be taken by home seekers if open for entry. Its inclusion in a forest

reserve would therefore retard and injure the development of the country."

The policy of the Government is against the inclusion of agricultural lands in forest reserves, and where any considerable area of such land has been withdrawn it will be cut out of the reserves and again opened for settlement. Where the agricultural lands are only a very small part of the whole area, and consist of little patches scattered through a rough mountain country, it would seem to be to the best interest of the whole people to include them within a reserve, as the increased area which could be irrigated from a protected watershed would greatly exceed the area of agricultural land in the reserves which settlers would be deprived of. Even if land is included within the reserves which does not now appear to be of importance for agriculture, but through changes in conditions should afterwards become desirable for homestead settlement, it can be eliminated and no harm will have been done by its temporary protection.

6. "That private capital will not build railroads into the forests for lumbering when securing timber depends upon purchase under forest reserve regulations, and that counties having large forest areas and timber resources away from necessary transportation would therefore be retarded in their development."

The timber product of California is far in excess of the present or any probable future local demand, and a large proportion of the lumber produced is for export trade. The non-export clause of the forest reserve law has been found to be a disadvantage in some of the other states, and its modification has been requested so as to permit the exportation of forest reserve timber from the State in which it is cut, whenever it can be established to the satisfaction of the Secretary in charge of forest reserves that the supply of timber in any forest reserve is clearly in excess of the local demand.

The annual lumber production of California is about 650,000,000 feet, about one-half of which is from the Redwood belt along the coast. The annual output of the sawmills in the basin of the Sacramento River is estimated at about 175,000,000 feet.

In one part of the district examined last summer it is estimated that at present there are about 45,000,000,000 feet of mature timber, or enough to supply the present demand from this part of the state for about 250 years. So it will be seen at once that a reserve policy for this district should be very liberal, as an increased market is necessary for the proper handling of the forest crop.

Large areas of the choicest timber are in the hands of private owners, and the creation of a forest reserve where the building of railroads has already been contemplated, would probably not retard the same as ample provision for right of way through the reserves is made by law. Transportation facilities are necessary for handling the timber crop of these reserves, and the policy of the Government should be to encourage the building of such roads as will be needed.

7. "That the timber product of the forest is in excess of the local demand and export trade is necessary for the proper handling of the forest crop. The non-export clause of the forest reserve law would therefore be injurious."

That this objection is well-founded has already been acknowledged.

8. "That the prolific growth of young trees after cutting makes forest protection unnecessary."

This opinion is disputed, but I will confine myself to quoting Mr. Gifford Pinchot's answer to this objection.

"It is true that natural reproduction is prolific in Northern California, but vast areas of forest land have been converted into chaparral by wasteful cutting followed by repeated fires. Forestry will keep such lands producing trees

instead of brush. There is no question which is the more desirable. Cutting under the principles of forestry is practicable. We know this because such cutting is going on with success under all sorts of conditions in different parts of the United States."

9. "That the forest is unnecessary to regulate the flow of streams, but, on the contrary, wastes the water by absorbing it."

This objection is one which is advanced by many opponents of forest reserves in California and is usually founded on some story of a personal experience. In talking with one gentleman, he told me that he had piped the water to his house from a little spring on the hillside above, and thought it would improve the place to have a few shade trees around the little spring, so he set them out. In the course of a few years, as the trees grew, the supply of water from his spring decreased until it was insufficient for the needs of the house. He cut the trees down and cleaned the roots out from around the spring, and immediately the water supply became normal again. He was convinced that forests did not conserve the water.

Fortunately, we have in the proposed reserves of Northern California a good illustration of the effect of forest destruction upon water flow. This is the case of the North and South forks of the Yuba River, of which Mr. Lippincott told you the other evening.

Originally the forest conditions on the two streams were about the same, and the flow of water similar. In the basin of the South Fork the timber has been cut with no thought of the future. A large proportion of the area has been worked over in hydraulic mining, and the soil washed away. This basin is now one of torrential floods, and it has been necessary to build an expensive system of storage reservoirs to hold back the flood waters for summer use. On the North Fork the timber is away from transporta-

tion and has not been cut so extensively, and a much smaller portion of the basin has been mined. Here the conditions are nearer natural and the water flow of the stream continues quite regular.

While there are sometimes exceptional cases where the forest does not appear to conserve the water, it has been proved beyond a doubt by the experience and investigations of the past that forests do regulate the flow of streams.

10. "That through insufficient appropriations, or otherwise, the forest reserve service is likely to be inefficient, so that the people will be injured by being deprived of the use of the lumber and pasture lands by reason of their being in a reserve."

While it is quite natural that mistakes should be made in the working out of so large a proposition as the management of the forest reserves, the Government has corrected many of them already, and will continue to improve the service.

The sentiment of the people is gradually becoming more favorable to the forest reserves, and Congress, recognizing their usefulness, becomes more liberal in its appropriations each year.

We must manage the reserves in a manner which will convince the people of their value if we expect the reserves to stand permanently. We must be liberal in dealing with the people after the creation of new reserves, and be careful not to injure existing industries unnecessarily.

As the people realize that the creation of forest reserves does not mean that they are to be deprived of any proper use of their resources, and that the conservative use and protection of the same is essential to the future prosperity of the commonwealth, the opposition to the reserves will gradually disappear and the sentiment in their favor become almost unanimous.

THE GREAT KANSAS RIVER FLOOD OF 1903

GEORGE L. CLOTHIER

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The greatest calamity that ever befell the people residing in the Kansas River Valley was the flood of 1903. Nothing like this flood had occurred in the region since the country had been inhabited by civilized man. The Indians say that in 1844 the stream was as high or higher than it was in 1903, but it is certain that if it was, the waters at that time did not make a hundredth part of the changes in the geography of the country that took place last May and June. The flood of 1844, and previous floods, left some marks on the valley which can now be interpreted since the recent great disaster, but it will take centuries to efface the changes of 1903 and bring the valley back to the same even surface of valuable farm land that it possessed prior to the great flood. In this work of reclamation forestry can play an important role.

The Kansas River Valley is a broad, flat, alluvial flood plain, occupied in former geologic ages by a stream extending from bluff to bluff. The ancient river cut out a trough a hundred feet or more in depth in the carboniferous formation of which the country is made, and subsequently partly filled this trough with deposits. The material filled in was largely sand, although this is not universally true because old layers of black soil several feet in thickness were unearthed by the recent flood, 20 to 30 feet below the present surface. The later deposits, no doubt, came chiefly from the adjacent high prairies, as they consist of 2 to 4 feet of the finest and richest soil possessed by the State of Kansas. The soil had been built up over the sandy subsoil through the help afforded by the prairie grasses and forest

growth which caught and held the fine materials. Man has largely destroyed the natural vegetative cover, leaving the soil bare and exposed to erosion.

This river drains a basin of more than 60,000 square miles, or an area one and one-fourth times the size of the State of New York. A large part of the drainage basin is regarded as belonging to the semi-arid regions.

The climatic conditions of this region in 1903 were anything but arid. The average rainfall of the most humid, eastern, part of the basin is about 35 inches per annum, while in the extreme west it does not exceed 15 inches. In the month of February, 1903, the greatest snowfall recorded occurred throughout the western half of Kansas and on the plains of eastern Colorado. In April the rainfall ranged from 3 to 5 inches, causing every stream emptying into the Kansas River to be high. In May the great downpour which caused the flood occurred. At Salina 17.34 inches fell during this month, and 5¼ inches in 24 hours. At Republic 17.13 inches fell, Frankfort got 16.34 inches, Hanover 14.25 inches, and Wamego 13.11 inches.

The amount of water that was discharged by this great river from May 28 to June 5 was so enormous that one can hardly comprehend it. Citizens of a mathematical turn of mind who saw the flood say that it would have required levees 120 feet high to have confined the stream in the space occupied by its normal channel. For nine days a sheet of water averaging two miles in width and fifteen feet in depth swept down over this great valley at a rate of six to eight miles per hour. If this sheet had been stretched out in one straight line it would have been 1,200 miles long.

The amount of physical energy exerted by the waters during the flood is almost beyond the comprehension of the human mind. The simple matter of sediments carried called for the expenditure of millions of foot pounds of en-

ergy. Haworth says that the material deposited was sufficient to cover the entire valley with a film four to six inches thick. If we estimate that the film averaged only four inches thick over the inundated area of 190,000 acres, or 70 per cent of the valley, the deposited material amounts to 538 cubic yards per acre, or a total of 102,220,000 cubic yards for the valley from Kansas City to Junction City. Steel bridges were wrenched from their foundations and converted into masses of contorted metal; railroad tracks were torn up and both ties and rails carried for hundreds of feet from the roadbeds; buildings were demolished as though they were toys; trees were uprooted and strewn over the farms for miles down the stream from where they grew; and worst of all for the people, great holes 40 acres in extent and 30 to 40 feet deep were gouged out of the midst of the finest farms of the State. The river changed its channel in five different places and cut partial channels in scores of other places. In fact it has started to cut across almost every body of bottomland intervening between two adjacent bends in the channel. Thousands of acres of land have been filled with holes and lakes or claimed by the permanent bed of the stream. Thousands of acres in addition have been buried in coarse sand to a depth that prevents their utilization for agriculture.

The Kansas River Valley from Kansas City to the mouth of the Republican River embraces an area of approximately 270,000 acres. Before the great flood of 1903 this land was worth on the average about $100. per acre or $27,000,000. The flood submerged at least 70 per cent of the area of the valley, or 190,000 acres. When the river receded within its banks it was found that a new map of the country was needed. Scarcely a mile of the river bank is located exactly where it was before the flood. The new channels aggregate 7 miles in length and ultimately will have shortened the

stream 14 miles. The old channels are either filled with sand and silt or are in process of filling, so that within a very few years the new channels will be the permanent location of the river.

The whole submerged area of the valley with the exception of the washouts was covered with alluvial deposits. Many places were observed by the writer where barns and other out buildings were half buried in silt. Frame houses on the farms were often prevented from floating away by being weighted down with silt. Abandoned houses were noticed with the dried mud 4 feet deep still on the lower floors. Thousands of acres were covered with new soil to such a depth that a plow will not touch the old soil, while many thousand acres more were covered with sand from 1 to 8 feet in depth.

Until 1903 the eastern half of the valley had been a great potato producing section. The average area planted was 10,000 acres and the average crop was 2,000,000 bushels. This crop was totally destroyed in 1903, causing the loss of no less than a half million dollars on this item alone. Other staple crops on approximately 100,000 acres were destroyed, but a large portion of this area was replanted after the flood to corn or forage crops, and the use of the land was not entirely lost for the season. It is probable that at least 35,000 acres, upon which the crops were destroyed, were allowed to lie idle after the flood.

No less than 10,000 acres have been rendered worthless for agricultural purposes, and an equal area has been damaged to the extent of 50 per cent of its former value. The general depreciation of land values throughout the valley caused by the threatened danger of future overflow is conservatively estimated at 30 per cent of the worth of the remaining 250,000 acres or the enormous sum of $7,500,000.

The following estimate of the amount of damage wrought by the great flood of 1903 is probably under rather than over the real losses sustained by the people of Kansas:

10,000 acres land destroyed for farming @ $100 per acre	$ 1,000,000
10,000 acres land damaged 50% of its value @ $100 per acre	500,000
250,000 acres land depreciated in market value 30% @ $100 per acre	7,500,000
Crops and grain on hand destroyed	1,000,000
Live stock drowned	500,000
Goods in storage or transit destroyed	5,000,000
10,000 residences and other buildings injured or destroyed @ $500 each	5,000,000
40 steel bridges destroyed @ $25,000 each	1,000,000
100 miles railroad track destroyed @ $5,000	500,000
Total	$22,000,000

The damage caused by the flood on other streams in Kansas without doubt aggregated $3,000,000 more, so that the total loss due to this great disaster was $25,000,000 in one State alone. To this vast amount of property destroyed must also be added the loss of almost 100 human lives.

Floods are caused by two physical conditions; namely, uneven topography, and obstructions in the path of the escaping rainfall. Of course, a third condition, abundant rainfall, must always be present, and was present in Kansas in 1903, but that is implied. If the surface of the State of Kansas were as smooth and even as one great pane of glass, and possessed a uniform pitch of 7 feet to the mile, corresponding to the average slope of the country between the western border of Missouri and the eastern boundary of Colorado, any amount of rain that could fall would not produce a flood in Kansas because the water would run off as fast as it fell. If the hypothetical pane of glass were made of separate pieces with different degrees of pitch, floods would occur wherever a trough would be formed by the junction of two surfaces of uneven or dissim-

ilar pitch. In spite of the fact that Kansas is located partly in the Great Plains, and does not possess an elevation within her borders that can justly be dignified by the name of mountain, there are enough features of uneven topography to cause the waters to accumulate after a great downpour of rain.

The surface cannot be changed by man, so in his efforts to control the floods he must necessarily limit his activities to the removal of obstructions from the path of the escaping waters. Fortunately this proposition is not of such magnitude as to prevent its successful accomplishment, in a large measure, in Kansas.

During the past fifty years the "industries of civilized man in Kansas have very materially changed natural conditions." Unfortunately almost every change produced has been of such a nature as to render floods more destructive than they were when the country was unsettled. One of the most powerful influences that has helped to aggravate the conditions producing floods, is the method of tilling the soil that prevails over large areas of the country. The land is devoted to the production of corn year after year without any rest, and the soil is kept bare of protecting vegetation for a major part of the time. The soil is thus exposed to very rapid erosion. The material washed away from the corn fields by every summer shower is carried down the streams, and much of it is deposited in the water ways. There is abundant evidence that previous to the flood of 1903 the bed of the Kansas River had been filling up with silt for the past half century. Besides the deposits of silt which are incident to the industries of man, artificial obstructions too numerous to mention in detail have been placed in the channel of the stream. For example, at Kansas City the channel has been narrowed to almost half its original width by artificial fillings. At Lawrence a dam was placed in the channel which caused the flood of 1903 to

cut a new channel around this obstruction. At Topeka a huge arch bridge of concrete had been completed but two or three years prior to the flood. This immovable structure acted as a dam and caused the water to rise several feet higher than it would naturally have risen in North Topeka, creating conditions which were largely responsible for the great destruction of life and property at this place. Railroad companies and municipalities have erected earthen embankments as approaches to almost every bridge crossing the stream, and when it is remembered that 40 bridges were destroyed in the great flood it will be seen that such obstructions must have had considerable influence in causing the waters to accumulate.

The greatest obstruction to the rapid escape of the waters from the Kansas River is the crookedness of the stream. The valley from Kansas City to the mouth of the Republican is 120 miles long by an air line. The water prior to the flood traveled 191 miles to reach the Missouri. The great flood shortened the channel 14 miles by making 7 miles of new channel. The water now travels 177 miles to reach Kansas City. The average grade of the valley is 2.8 feet per mile and is almost uniform throughout its length of 120 miles. The average grade of the river bed before the flood was 1.7 feet per mile; it is now 1.9 feet per mile. When the stream got out of its banks, the water traveled by the shortest route down the incline and, of course, over a grade much steeper than obtained in the river bed. This one fact explains why the eroding effect was so terrible at distances of miles from the channel, and why new channels were partially or wholly cut from bend to bend at so many places in the valley. If the bed of the stream were so placed as to conform in direction with the general trend of the valley the grade of the bed would be the same as the average grade of the valley. With such a proposition the current in the channel would be just as swift as, or even

swifter than, it would be if it were flowing in a broad sheet over the farm lands as in June, 1903, because the grades in the two places would be equal and there would be much less friction to retard the current in the channel than on the farm lands.

By making 50 miles of artificial cut-offs the river channel could be very much straightened and reduced to 137 miles in length. This is the exact length of the Union Pacific Railway which follows its course. If shortened to this extent the grade of the river bed would be increased to 2.4 feet per mile. Such treatment would result in a gain in the carrying capacity of the stream attributable to the following three factors:

1. The friction on the banks would be greatly reduced, lessening the tendency towards erosion.

2. The rate of movement of the water would be greatly accelerated because of the increased grade of the bed.

3. The distance to be traveled would be considerably shortened.

These three elements of saving would just exactly double the carrying capacity of the stream. It is not certain that such a change made prior to June, 1903, would have wholly prevented the stream from overflowing its banks, but there is not the least doubt that the destruction of life and property would have been very much less with such an increase in the carrying capacity of the river. The great trouble with the Kansas River in 1903 was that its main current would not stay in its bed but pursued its course across the farms by the shortest route. If the channel were straightened and unbroken belts of forest trees were maintained along its banks, the writer believes that the valley would be guaranteed against a recurrence of such a disaster. If the river should rise in the future and overflow its banks, the forest trees along the stream would allow the water to filter through them upon the farm lands lying back towards the

bluffs. Such a quiet overflow would serve to enrich the land by deposits of silt instead of destroying the soil as was done in 1903.

As some engineering proposition will without doubt be brought forward for the permanent improvement of the Kansas River, it appears to the writer that the advisability of combining some form of forestry with the engineering scheme would be wise.

Before this great valley was settled by white men the land from Lawrence to Kansas City was covered with a heavy growth of timber, while large portions of the valley were timbered as far west as St. Marys. Wherever small groves have been allowed to stand, one finds that the natural forest was composed chiefly of very valuable species such as black walnut, oak, hickory, etc. In the past history of the valley each overflow caused a deposit of soil in the forest area so that when civilized man first settled the country this land was eagerly sought because of its great fertility. The timber, as elsewhere in the United States, was regarded as a detriment rather than an advantage to the land and of course it was cleared off as quickly as possible. When clearing the land, the farmers very seldom took the precaution to leave any forest on the banks of the river. There are a few exceptions to this general statement, which, because of the light they throw upon the problems involved, are worthy of close study. The most striking exception to the general practice of clearing the land is to be found on the island owned by Joab and John A. Mulvane, located about three miles southwest of Rossville. This island was formed artificially by the Mulvanes about 20 years ago. The river made a very sharp curve to the north at that place and then bent around again to the south and southwest almost forming a letter *S*. On the convex side of the curve the stream was constantly undermining the farm lands and causing the banks to cave in. Mr. Joab

Mulvane says that one flood in the early '80's caused the loss of 13 acres of good farm land in two days' time. He decided to remedy this evil by making a new channel for the river. The plan carried out was as follows: A ditch a few rods broad was made the shortest way across from bend to bend, the upper end of the ditch being graded down almost to the water level. The bottom of the ditch was carried along practically level so that at its lower end it came out several feet above low water mark in the river. When the first rise in the stream occurred Mr. Mulvane sent a man in a boat to keep the drift wood from closing the upper end of the ditch. This allowed the current to pass through the ditch unobstructed and the water as it passed through had to make a plunge of several feet to reach the channel at the lower end of the ditch. This created a waterfall which caused the bed to cut back up the ditch very rapidly. In two days' time the river had changed its course, and where previously the water had traveled around the curves three miles it now reached its destination by traveling half a mile. The amount of money that Mr. Mulvane spent on changing this stream was $500, besides the cost of the land which was demanded by the new channel. The change left an island of about 500 acres which was covered with a heavy growth of timber, and gave the Mulvanes at least 200 acres of "accreted" land as the channel of the stream had been "meandered" in the Government surveys. In clearing the island to bring it into cultivation Mr. Mulvane was very careful to leave a broad belt of timber next to the new channel and also a considerable fringe along the borders of the old channel. The subsequent freshets in the river soon filled the upper end of the old channel and young trees got a start here. At present, at least three-fourths of the old channel is dry land and covered by a growth of cottonwood and willow trees, 6 to 12 inches in diameter and 60 to 80 feet tall. The great flood of 1903

submerged this island several feet, and while Mr. Mulvane lost some personal property his land was not damaged in the least; in fact, the soil has been built up with a deposit of fine, rich silt from 6 to 18 inches in depth all over the surface of the island. The effect of this body of timber on the Mulvane place was not only beneficial to Mr. Mulvane but it prevented the erosion of the valley lands for several miles down the stream, its beneficial effects being traceable by the deposits of silt that occurred.

Immediately west of the Mulvane property is a tract of 300 acres owned by Mr. Horace Adams. Mr. Adams, not appreciating timber, nor fearing damage from the river, cleared his land close to the river bank. The flood came rushing across his land with terrific velocity, plowing up and carrying off the soil for a depth of 6 to 8 feet over an area of 16 to 18 acres. On nearly 100 acres of Mr. Adams' land coarse sand was strewn to a depth of one to three feet, rendering the land practically worthless for agriculture.

Another very notable example of the value of forest trees in protecting the land is found on the Lothholz farm in the Weaver Bend about 3 miles northeast of the town of Eudora. Most of this farm was cleared when Mr. Lothholz purchased it, but a tract of about 30 acres abutting on the river at the north end was still left in timber. The forest had been removed from the land on the river bank for a distance of about a mile south of this body of timber. The stream here makes a sharp turn to the north while the general trend of the valley is towards the east. At this bend in the river the water rose and overflowed the farm, passing by the shortest route across to the nearest bend two or three miles further east. The current was so swift and the soil so soft that the flood gouged the surface of the ground full of holes, varying in size from a few feet in diameter to several acres in extent. More than a hundred acres

had the surface soil removed for from one to three feet in depth, the ground being left in a condition of veritable bad lands, while at least 25 acres of the farm were appropriated by the river bed. The portion of the farm which lies directly east of the timber lot, and adjacent farms in that direction, were not injured in the least by the flood. On the contrary, a deposit of silt several inches in depth covered and enriched the soil of almost a hundred acres on the lee side of this timber belt. If the most of the forest on the Lothholz farm had not been removed from the river bank there is not the least doubt that the damage to the lands further down the valley in the Weaver Bend would have been much less.

Another case in this same valley shows very clearly the beneficial influence of timber and the harmful result of clearing too much land. On Mr. John Kindred's farm there is a tract of about two or three acres of timber bordering the river bank, while directly south of this tract on the adjoining farm the timber has been cleared away in order that the land might be put under cultivation. The water came through on the neighboring farm south of Mr. Kindred's grove, cutting a wide channel diagonally across the Kindred place almost down to the low water mark of the stream and scattering sand over many acres of fertile land farther down the valley. The grove of timber on the Kindred place, like an island in the midst of the flood, caused the current to divide, one portion flowing in this newly excavated channel and the other part keeping in the old river bed. On the lee side of this grove of trees the deposit of silt is 5 or 6 feet deep in places. There is not the least doubt that similar deposits of silt would have been formed farther south where the erosion took place if the original belt of trees had remained standing along the river bank.

One of the most evident cases of damage caused by clearing the land occurred in the bottom south of Wamego in

Waubaunsee County. The river at this place makes a curve to the north flowing across the valley from south to north. A tract of very valuable agricultural land several thousand acres in extent occupies the bend of the stream opposite to and south of Wamego. The land in this part of the valley was somewhat sandy before the flood and particularly well adapted to the growth of sweet potatoes. Because of its great fertility and worth, it was subdivided into small farms. Every acre of such fertile land was prized highly and the owners of the farms adjoining the river bank often attempted to get all the land they could by clearing away the forest and putting the soil into cultivation, almost to the water's edge. A farmer named Stewart, owning the land on the convex side of the curve cleared a strip of timber from the river bank, while the next neighbor to the north left the natural timber standing. The timber on the bank towards the southwest had also been left standing. This cleared strip was probably 1,000 feet long and 150 feet broad, containing less than 4 acres. The removal of the timber opened a gateway for the floods to rush through. The eroding water left an embankment immediately next to the river just about wide enough for a good wagon road, but east of this enbankment, it gouged out a lake 300 or 400 feet broad and almost half a mile long, embracing 25 or 30 acres, and the sand removed in the excavation of the lake was strewn over several hundred acres of land to the east rendering much of it almost worthless. If the erosion had continued a little longer the stream would have changed its course here and cut through fertile farms a distance of 3 or 4 miles, leaving the Wamego bridge, which originally cost $40,000, spanning an abandoned river bed. In order to gain the use of 3 or 4 acres of land the man who cleared the river bank unwittingly was the cause of damages to himself and neighbors to the extent of from fifteen to twenty thousand dollars.

The forest planter can do a great service for the Kansas River Valley if he will establish groves of trees on the banks that are being eroded by the current. Wherever the river has changed its course it plowed through farms composed of bare soil. Consequently the banks of all these new channels are perpendicular and rapidly caving off. One of the first efforts of the tree planter should be to establish these banks permanently since, in almost every case, the change in the course of the stream has been a vast benefit to the valley as a whole by shortening and straightening the river. The best way to fix caving river banks is to get them clothed with a growth of willows as soon as possible. Willow poles should be cut when the buds are dormant, and after having been fastened to woven wire they should be pushed over the bank so that their butt ends will fall into the water and sink into the soft soil at the foot of the crumbling bank. In a very short time these willows will strike root and if held until they have permanently anchored themselves they will form the most perfect protection to the banks. Some years ago the Blue River to the northeast of Manhattan, Kansas, only a few hundred feet from its junction with the Kaw, was invading the city so rapidly that an unused railroad track fell into the stream in one night. The Mayor of the City ordered that the caving bank be protected by a revetment of willows. The willows grew and now form a perfect protection so that there has been no loss of land on that side of the city for twenty years past.

The observations made of the action of the flood of 1903 suggest the following recommendations.

1. The damaged lands in the Kansas River Valley should be planted to forest trees at once to assist in their reclamation. The young cottonwood seedlings encumbering thousands of acres of good plowland can be utilized for transplanting to where the sand is deep, while the eroded

lands should be planted with such species as black walnut and hardy catalpa.

2. The stream should be straightened and means provided for keeping it straight. When once straightened very little expense will be necessary to keep it straight, as undercutting is much more rapid and violent in a crooked stream than where the channel is straight. The banks should be made sloping and kept covered with vegetation, as a sloping bank is held in place by the downward pressure of the water, and the vegetable covering prevents the waves from undercutting.

3. The banks should be fixed by the use of revetments of willow poles fastened together with woven wire and securely anchored by cables to posts until the poles have rooted. By this means sloping banks can be established and maintained.

4. Belts of forest trees 250 feet wide should be planted on both banks of the stream from Kansas City to Junction City. These will act as levees in holding the main current in the channel and relieving the valley of the danger of crevasses. The overflow when it occurs will be gentle and quiet, enriching the farm lands back of the protective forest belts instead of destroying them as happened in 1903.

5. The old river beds abandoned recently or created by the straightening process should be allowed to grow up to cottonwoods and willows. Such lands will become very valuable for agriculture when the depression where the river flowed becomes filled up.

THE NECESSITY FOR SAVING THE FORESTS ON THE WATERSHED OF THE SACRAMENTO RIVER

J. B. LIPPINCOTT, ENGINEER U. S. RECLAMATION SERVICE

Delivered before the Society January 20, 1904

I wish to say, gentlemen of the Forestry Bureau and of the Reclamation Service, that it is a very great pleasure indeed for me to be able to address you this evening, though I naturally have a great deal of hesitancy in talking forestry to forestry experts.

In the judgment of a great many of us the great Central Valley of California, as it is called, which includes the Sacramento and San Joaquin valleys, is one of the greatest opportunities for the development of irrigation that we have in America. The members of the Geological Survey have so regarded this valley for a long time, and consequently when the California Water and Forest Association, and other people in the State of California who were interested in the development of that commonwealth, took up the question of irrigation and forestry there, we naturally fell in with the idea, particularly with reference to the general extension of the forest reserves of the State.

The Sierra Club of San Francisco was the first organization to advocate the creation of forest reserves in the Sierras, and they did quite invaluable work in aiding in the creation of the Yosemite National Park. The Water and Forest Association of California undertook the promotion of the idea for the extension of these forest reserves. After looking over the field it was concluded that the portion of the State that was capable of as great development as any other section, was the Sacramento Valley. We were confronted with the fact that the forest lands in the drainage basins of

the Sacramento River were being rapidly denuded and overgrazed. The old timers, the 49'ers, told us that sea-going vessels used to sail up the Sacramento River as far as Sacramento City and unload their cargos. The river to-day is a shallow stream, navigable with difficulty by flat bottomed river steamers. The channel has been largely filled with debris from hydraulic mining and natural erosion. The temporary withdrawal was obtained of a great area of mountain forest lands, extending from Lake Tahoe to Mount Shasta and in certain portions of the Coast Range. These withdrawals cover about 12,000,000 acres. When the reserves were proposed the intentions of the Government were very largely misunderstood and it was a very difficult thing indeed to get any satisfactory explanation of their purpose before the people of the State. The locators of timber land under the Timber and Stone Act advertised their filings, as required by law, extensively in the local papers, and these advertisements were so lucrative to many of the newspaper men, that apparently they did not like to favor the creation of the reserves, and the lumbermen wanted to go ahead locating lands. Consequently there have been a great many protests against the permanent creation of these reserves. The purpose of this discussion is to show, from an irrigation standpoint, some of the reasons why these reserves are favored.

The Sacramento Valley contains about 2,600,000 acres of valley land. The Sacramento River has a mean annual discharge of 25,000,000 acre feet. The San Joaquin Valley contains 7,300,000 acres. The San Joaquin Valley is about as much developed now, from the unregulated flow of its streams as can well be done, though the irrigated area can be extended by storage of flood waters and by pumping. This is not true of the Sacramento Valley. This great district, lying near the heart of California, with a navigable river flowing through its center, with a great railroad system,

semi-tropical climate and a water supply which is ample for the reclamation of the entire valley, possesses apparently every opportunity for intensive cultivation by irrigation. You will find orange trees at Red Bluff in the extreme northern part of the valley. The Weather Bureau Station at Red Bluff, which has been maintained for 15 years, shows an absolute minimum temperature of only 18 degrees. In Southern California we have extreme temperatures as low as that in some of our orange growing districts. At Oroville, on the east side of the Sacramento Valley above the town of Sacramento, orange groves are bearing fruit commercially, and we also find along the west side of the valley some citrus orchards. It should not be inferred that the entire valley should be devoted to the growing of citrus fruits. Doubtless the future will show that as a commercial proposition they will have to be restricted to certain favored foothill localities, but these facts indicate that the Sacramento Valley is capable of producing the same class of products grown in Southern California. At present the predominating crop is grain, which of late has ceased to be as profitable as formerly, and the country is not up to the standard of development it should be. The greater part of the valley in its central portion is a flat plain. These lands are capable of being utilized for stock and dairy farming and other high-priced products. The maximum temperature at Red Bluff is about 114 degrees, and the minimum 18 degrees. The rainfall varies from 15 to 20 inches, occurring exclusively in the winter months. The Coast Range lies along the westerly side and the Great Sierras on the east side of the valley. The rain clouds approaching from the ocean precipitate their moisture mostly in the mountains, a maximum of about 60 inches occurring annually in the higher Sierras.

The elevations of the Coast Range are from 3,000 to 5,000 feet, and of the Sierras from 8,000 to 12,000 feet.

The precipitation on the Coast Range is largely in the form of rain. The fact that these elevations are relatively low gives a winter and an early spring stream flow of a high volume, and the low water condition occurs earlier in the summer than it does in the high Sierras on the east side. In the high Sierras the precipitation is mainly in the form of snow, and when the melting period comes in May and June, the streams rise in their annual flood when the water is needed for irrigation. The low water period is from July to October. While the total volume of water is ample, it requires regulation both by forest preservation and the construction of storage reservoirs, if irrrigation, navigation and power interests are to be conserved. Such protection of the streams will also tend to relieve the erosion of the mountain debris into the navigable channels.

Two examples will serve to show the value of a forest cover. The first is Cedar Creek in the State of Washington. The drainage basin is 143 square miles. In the year 1897 the minimum flow was 294 and the mean 1,089 cubic feet per second. The maximum flow of water was 3,601 second feet. The stream flows with great constancy and without any material erosion of its bed. The drainage basin is heavily forested. Such a stream is naturally adapted to human requirements.

Queen Creek, Arizona, is a stream with a barren basin of 143 square miles. The gagings for the year 1896 show a flood discharge of 9,000 cubic feet per second of turbid water which carries great quantities of silt and debris, or about twice as much as the flood flow in Cedar Creek. On Queen Creek the observer had to live on the ground, waiting for the intermittent flood waves to go by, always ready to make his measurements. The usual condition of the creek was practically dry, and the mean flow was but 15 second feet. While it may not be entirely fair to make a comparison between these streams, they are so strikingly

different in regimen that the comparison is of interest. On Cedar Creek where the rainfall is far the greater, the great regulator is the forest.

Such examples, which could be given for many other localities, are the justification for the strong agitation for the preservation of the forests of the Sacramento basin. Prior to the withdrawal of these timbered areas they were being taken up at such a rate by lumber companies that there would be no public timber left inside of a very few years.

While we are interested in the forest reserves from the standpoint of the engineer, we should not belittle the importance of the forest reserves for a continuous supply of lumber. The Sacramento Valley will be thickly populated as a result of its ultimate development. If this great area of 2,600,000 acres is to be made permanently productive, the streams must be protected or else its proper development will be an impossibility.

Two branches of the Yuba River afford an interesting comparison. The North Fork has a drainage area of 146 square miles. On September 1, 1903, the stream in that branch of the river was flowing 113 cubic feet per second. The drainage area is well timbered, and has not been extensively burnt or cut over. The South Fork of the river has 120 square miles of drainage area. Most of it has been cut and burnt over. The normal condition of that branch of the river, which is separated from the North Fork by an east and west ridge, was dry for 120 days out of the year in which observations were made. A number of storage reservoirs have been built in that tributary for mining and power purposes. We have therefore two forks of the same river, draining nearly equal areas, one with a well sustained stream flow, the other practically dry in the summer. One basin is timbered, the other denuded, and in the denuded area a number of storage reservoirs have been built, possibly to compensate for the destruction of the forests. Things

like this make us pause when we consider the Sacramento Valley with its fertility of the soil and great possibilities.

There is quite a strong resemblance between the valley of the Sacramento and the valley of the Po in northern Italy. In northern Italy irrigation has been practiced since the time of Cæsar and irrigated lands have increased in value during that period of time. The irrigated lands of the valley of the Po support 400 people to the square mile, and the value of irrigation, even with ample rainfall, is a demonstrated fact. The rainfall at Milan is about 42 inches annually and over half of that occurs in the six summer months, or during the growing season. In the Sacramento Valley the rainfall amounts to less than 20 inches; normally there is no rain in that valley from the first of April until the latter part of October, still the people hesitate about beginning irrigation. The average size of a farm in Glen County, in the Sacramento Valley, is 1,500 acres. There are but two school children to the square mile. The population decreased about ten per cent between the Census of 1890 and that of 1900. That county can grow all the crops that are produced in Southern California. In the neighborhood of Riverside, in Southern California, there are 13,000 acres under cultivation; on a portion of this area the fruit trees are not mature, yet over 10,500 people live there in comfort and even luxury. They have electric lights, street cars, and many banks and churches.

The Sacramento River is a navigable stream and is of value, not so much for carrying freight as for a regulator of freight rates. The southern-central part of the Sacramento Valley is subject to overflow during high floods, requiring extensive levees.

An adequate irrigation system for the Sacramento Valley should contemplate the storage of flood waters in reservoirs and the diversion of water from the streams during their

higher stages directly into the irrigation canals. When the low water period begins to interfere with navigation, then the irrrigation canals should obtain their supply from the reservoirs. A large number of reservoir sites have been found in the Sacramento basin which could be used in carrying out such a program. The State of California has recognized the great opportunities for such development, and at the last session of the legislature made an appropriation to assist the Geological Survey and the Bureau of Forestry in a general forestry and irrigation study.

It is the intention to complete a topographic, hydrographic and forestry survey of the Sacramento basin, and combine the whole into a report for wide distribution.

RESULTS OF A ROCKY MOUNTAIN FOREST FIRE STUDIED FIFTY YEARS AFTER ITS OCCURRENCE

W. J. GARDNER

Delivered before the Society April 28, 1904

Last summer the Bureau of Forestry undertook an examination of the condition of the forests on the southern portion of the Pike's Peak Reserve. The main purposes of the examination were to find out to what extent the denuded slopes of this important watershed (the source of water for Colorado Springs and of power for Cripple Creek, Pueblo, etc.) are naturally reforesting, and whether it is advisable to assist the natural reproduction by planting.

We confined our work to that fraction of the reserve which lies south of the Cog Road to the Peak — a fraction closely corresponding to Ranger District No. 3. This region comprises nearly 79 square miles of extremely rugged mountain land extending in a rude square southward from Pike's Peak. Save for a narrow border on the eastern edge, granite is the rock of these mountains, which are characterized by steep, rocky slopes and frequently sharp peaks and crests. Deep, narrow canyons divide the mountain ridges. There is very little level land, only a few small meadows and occasional grassy spaces above timber-line. The altitudes range very high. From elevations of 6,500 to 7,000 feet in the eastern and southeastern borders of the reserve the land rises steadily toward the northwest corner of the district examined and culminates in Pike's Peak at an altitude of 14,147 feet above the sea. More than 56 per cent of the district lies above the 9,000-foot contour.

What has been said about topography enables one to guess the character of the forest of this region. It is

composed of slope types and is modified by high altitude. Three and one-half square miles lie above timber-line. Below timber-line it is possible to distinguish four forest types, arranged fairly well in three altitudinal zones. These are Engelmann spruce, limber pine, red fir and bull pine, which may be briefly located as follows: The *Engelmann spruce type*, consisting of Engelmann spruce with an admixture of limber and bristle-cone pines, extends from timber-line (which in the Pike's Peak region varies from 11,800 to 12,000 feet) down to 10,000 feet, with scattered patches frequently lower. It is found but rarely on southerly exposures, save in the higher parts of its range. The *limber pine type* runs from 11,000 feet down to 9,500, occasionally as low as 9,000 feet. Thus there is considerable overlapping with the lower half of the spruce belt. The *red fir and bull pine types* together form a belt extending from 9,500 to 7,000 feet altitude, the former occupying the higher slopes, even above 9,500 feet. The red fir type usually occurs on north, east and west exposures, the bull pine commonly on southerly.

In the bull pine forest there generally occurs a mixture of red fir, and sometimes white fir and limber pine. The red fir type contains some limber and bull pine, white fir, and Engelmann spruce. The limber pine type contains a large proportion of Engelmann spruce, and frequently bristle-cone pine or red fir.

The Pike's Peak Reserve was, until comparatively recent times, well timbered. But a very destructive fire or series of fires has swept the region, destroying 75 per cent of the forest. Last summer we studied the remnants that escaped. The existing patches of virgin timber and fully stocked stands of young growth now occupy from 23 to 25 square miles of the area examined, or about one-third of the lands below timber-line. The rest of the country below timber-

line is either absolutely barren of living tree growth, or is supplied with very scanty conifer reproduction, or irregular and unsatisfactory stands of trembling aspen.

Very early in the field season evidence began to accumulate that the fire of which I speak occurred about 50 years ago. So various questions connected with this particular fire — such as its extent and the amount and character of the new tree growth succeeding it — soon came to be the main topics of study. Effort was made to show in the maps the amount of old timber left standing and of young growth which has come in since, and to learn why some slopes are reforesting while others are in practically the same state to-day that they were 50 years ago. A great many age counts and measurements were made in the young growth to determine how soon after the fire or fires most of the new trees began their life and how fast they are growing. Here was opportunity to study a very concrete case of the effects of forest fires at high altitudes.

The results of this fire will stand out more strikingly if I give the main features of the evidence placing the burn 50 odd years ago. However, I shall have to present this evidence very briefly or I shall be describing the results of the fire for which I am trying to find a date.

(a) *Counts of Fire-Scars.* If we leave out of consideration the scars from very ancient fires or clearly local ones, a study of fire-scars leads us to believe, first, that all the extensive burns in the district examined occurred in the years from 1846 to 1856; and, second, that the southern border of the Reserve was again swept by fire about 1880. Most of the scars, however, are from 53 to 50 years old, pointing to the years from 1850 to 1853 as the dates of the fires which caused them.

(b) *Ring Counts of Young Trees.* If most of the fire-scars are no older than 50 to 53 years we should expect none or very little of the young growth in the burns to be more

than 50 to 53 years of age. This is what we actually find to be the case. Out of counts upon 3,500 trees under 2 inches in diameter (b. h.) only 175 are more than 53 years old, while more than 50 per cent range from 20 to 50 years. The greater ages of these 175 trees may be explained in almost all cases by the fact that they were counted in virgin timber which escaped the fire. Since young trees, from 20 to 50 years of age and seldom older, are distributed in all the burns we can be pretty sure that there have been no general fires within the past fifty years and that the burns did not occur much more than 50 years ago.

Nor do we get different results by examining young growth 2 inches and above in diameter. These larger trees are found, whenever counted, to belong to the same generation as the smaller. There is a big gap between the mature stands that escaped the fire and the 50-year-old stands of which we are speaking. There had evidently been no general fires to break up the mature stands and start new forests of young growth before the particular fire or set of fires we are studying.

(c) *Lack of Written and Spoken Testimony as to Recent General Fires.* There appear to be no local records of general fires in the southern part of the Reserve since 1850. Nor have I been able to find any explicit written account of a big Pike's Peak fire either before or after 1850. There is a bare possibility that the fire described in the journal of George F. Ruxton, an Englishman who was hunting at the east base of Pike's Peak in March and April, 1847, may be this very conflagration. But it is a question whether this fire did not burn more plains than mountain land. If it is the fire that destroyed 75 per cent of the forest in the southern portion of the timber reservation it is very strange that the fire scars do not point to 1847 rather than to 1850 to 1853.

There were undoubtedly general forest fires in the central

Rockies in the middle of the last century. Last summer evidence was found of a big fire in northern New Mexico in the 50's.

As already stated, the fire of 1850 probably destroyed 75 per cent of the old forest. The remaining patches of virgin timber are of small extent, the best of them are usually on other than southerly slopes. A piece of mature woods one square mile in area can not be found. Existing mature forests are frequently much opened up by fire and sometimes, I believe, by other causes. Most of these forests have a large number of dead trees, sometimes where the evidences of recent fires are lacking. This is especially noticeable in the high spruce forests in the Seven Lakes region.

In general terms, the southern third of the district contains the least timber. Save for the red fir woods in the southeastern arm of the reserve, this territory is chiefly aspen land, with scattered single pines and spruces or very small tree patches.

Outside of the forested lands the reserve is everywhere strewn with dead trees, left from the old fire. In the lower elevations, where (in the red fir and bull pine belt) the woods were most open, and where they were at the same time most accessible to railroad builders, miners, wood haulers, etc., the greater part of this dead stuff has been removed. But in the higher places, and away from the well-traveled roads, great quantities of dead wood remain, both standing and down. Much of it is perfectly sound, especially the pine. It looks as if the dead bristle-cone pines at the highest altitudes never would decay. They are hard as stone, and often weathered into pitted surfaces like granite.

The reproduction of forests after the fire has been slow and irregular in the extreme. In some localities a new growth almost as dense as a field of grain now occupies the

ground. In others there is not a vestige of new growth among the bleached trunks of dead pines and spruces — not even aspen occurring. Between these two extremes may be found every degree of reforesting — scattered young pines and spruces in otherwise barren burns, mixtures of aspen and young conifers, patches and small groups of new growth, etc., etc. Of the lands burned in 1850 or thereabouts I do not believe that more than 10 per cent have been fully restocked with forest trees.

Aspen is very abundant in the burns of the southern third of the district examined. Farther north (and, in consequence, at the higher elevations) it becomes less and less abundant, some of the worst burns just south of Pike's Peak being practically free from it. Aspen has frequently been considered a nurse-tree to the conifers, an opinion which can not, I think, be assented to without qualification. We found very few cases where an aspen stand was sheltering a younger conifer stand. Usually, when counts were made to ascertain age in aspen and conifer young growth, the aspen proved to have started with the conifers or later. In other words, we seldom found cases where a burn was succeeded first by aspen growth and then by conifers.

Engelmann spruce, red fir and other species seem to come in after a fire quite regardless of aspen. But wherever the aspen does occur it undoubtedly acts as a valuable soil protector. If the reproduction of the conifers is very light aspen fills the gap temporarily, until the conifers themselves can occupy the ground. Thus it may be quite a valuable tree in protecting the soil during the long and irregular seed-year intervals of some forest species (like Engelmann spruce, perhaps). Certain it is that spruce, red fir, limber pine, etc., develop well when they come up with trembling aspen of the same or older age. The point we dispute about the aspen is, that there is a regular order in

the natural reforestation of Pike's Peak burns; first aspen, then coniferous growth.

The stands of aspen, especially those in the southern third of our territory, have been much injured by a recent plague of tent caterpillars. Trees killed by these insects are littering the ground along the south line of the Reserve and in the low hills just outside of this line. Thus the danger from new fires has been considerably increased in this section.

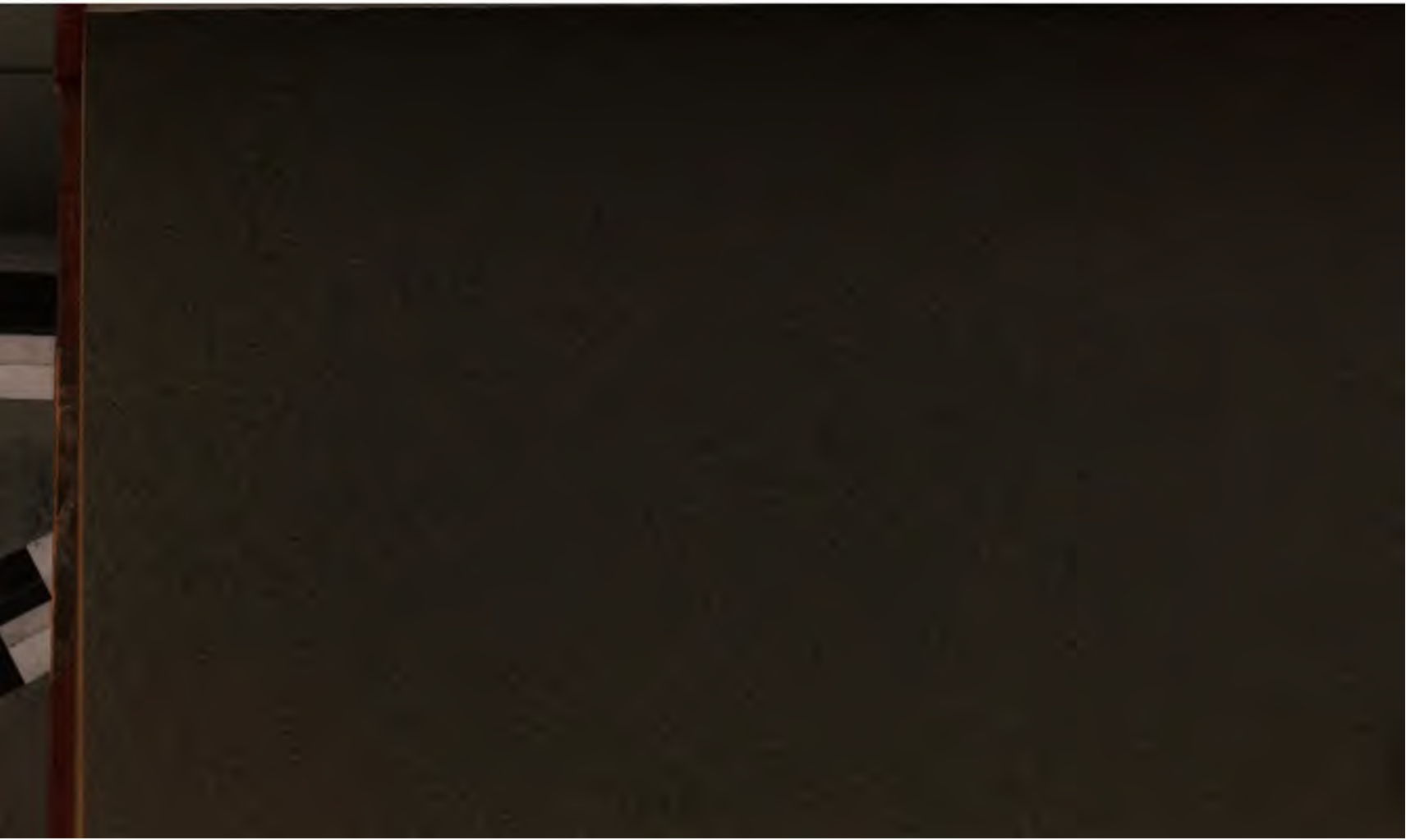
Of the species of conifers in the Pike's Peak Reserve, Engelmann spruce, limber pine, red fir and bull pine are the most abundant. These are likewise the most important elements of the young growth, Engelmann spruce, however, far outnumbers any of the others. Engelmann spruce usually came in most promptly after the fires, red fir next, and the pines latest of all. Owing to the importance of the spruce in point of numbers, and the way in which it illustrates the main features of forest reproduction in these mountains, I shall speak mainly of it in remarking upon the young coniferous growth.

Three-fourths of the young trees of this species are found to be 30 to 50 years old, 50 per cent of the young growth ranging from 35 to 45 years. If the record of fire scars on old trees may be trusted for the approximate date of the big burn, a great deal of new spruce growth started within 10 years after the fire. But strangely enough, there has been comparatively little young growth starting within the past 30 years.

These spruces grow extremely slowly in most cases. We have records of one 1.6 feet high and 45 years old, while trees 2 to 4 feet tall and 40 to 45 years old are quite common. These slow-growing trees are found both in virgin and in crowded young stands. At the other extreme we have record of an Engelmann spruce 45 feet high, 11 inches in diameter (b. h.) and 45 years of age. But on an average

it takes an Engelmann spruce 25 to 35 years to reach a height of 5 feet in this region.

In the stands of spruce which came up after the fire the heights range from 1 and 2 to 20 feet and over, but by far the greatest number will run below 15 feet. Most of the diameters are below 2 inches, although trees 35 to 50 years of age frequently are 2, 3, and 4 inches in diameter. The range of sizes for each age class is very great, in consequence of the tolerant character of the spruce. The dominant trees in these "50-year-old" stands are now growing in most cases at a good rate. But I fear that some of the densest patches of spruce reproduction will not develop into the mature woods we hope for. In our studies we found several very old pole stands of Engelmann spruce, where trees 6 to 7 inches in diameter were 250 to 270 years old. It is our opinion that some of the densest stands of young growth will develop into just such pole stands as these. The tolerance of Engelmann spruce is really remarkable. Trees in old crowded pole forests sometimes persist for 200 to 250 years without attaining a height of more than 10 to 15 feet.



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PROCEEDINGS
OF
THE SOCIETY OF AMERICAN FORESTERS

VOL. I APRIL, 1906 No. 3

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Meetings

During the year 1904-1905 the Society held eighteen meetings. The program follows:

1904

November 3. Executive Meeting.

November 10. Executive Meeting.

November 27. Preliminary Tests in Creosoting Loblolly and Shortleaf Pine Cross Arms.
HENRY GRINNELL

The Rüping Process of Creosoting, and the Results of Tests made at Perth Amboy, New Jersey. C. G. CRAWFORD

November 25. A Study of Red Gum. A. K. CHITTENDEN

Forestry in Japan. Y. OHTSUBO

December 1. Executive Meeting (Postponed).

December 8. What Principles of Taxation Should be Applied to Forest Lands? ALFRED AKERMAN

How Shall Forests be Taxed?
ALFRED GASKILL

December 15. What are the Essentials in a State Fire Law? E. A. STERLING

The Deficiencies of State Forest Fire Laws.
G. W. WOODRUFF

December 22. The Possibilities and Limitations of Government Coöperative Work with the Private Owner. GEORGE L. CLOTHIER
J. GIRVIN PETERS

1905

January 9. Executive Meeting.

January 12. The Uncompahgre Valley Project in Colorado. A. L. FELLOWS

Some Problems in the Storage of Water in New England. H. C. GROVER

January 19. Timber as a Structural Material. W. K. HATT

The Effect of Moisture on the Strength of Timber. H. D. TIEMANN

January 26. Deforestation in China. BAILEY WILLIS

Results from Applying a Working Plan to the West Point Military Academy's Forest Lands. ROY L. MARSTON

February 2. Executive Meeting.

February 9. Chaparral as a Watershed Cover in Southern California. L. C. MILLER

What is the Best Disposition and Use of Agricultural Lands within the Forest Reserves? H. J. TOMPKINS

February 16. How Present Methods of Handling Stock Affect the Public Range. A. F. POTTER

A Proposed System for the Regulation of Grazing on the Public Lands. F. V. COVILLE

February 23. Principles Involved in Determining Forest Types. RAPHAEL ZON

Why Prairies are Treeless. ALFRED GASKILL

March 2. Executive Meeting.

March 9. A Method of Fire Protection for Logged Forest Land in California. WILLIAM F. HUBBARD

PROCEEDINGS
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VOL. I APRIL, 1906 No. 3

HOW SHALL FORESTS BE TAXED?

ALFRED GASKILL

Delivered before the Society December 8, 1904

It is generally admitted that taxation in the United States is as faulty in principle and in practice as it can well be. A well-known writer,[1] in discussing the situation, says: "The outcome of all this is a system which powerfully contributes to arrest and hinder natural development, to corrupt society, and is without parallel in any country claiming to be civilized." This reproach applies with especial force to the taxation of woodlands, because the present practices favor and encourage the untimely or wasteful use of standing forests, discourage the propagation of others, and tend to hasten the time when the country shall be forced to face a wood famine.

The present paper, however, aims at no radical reorganization of the tax system. It simply presents the situation as it concerns the forest interests, makes several suggestions that seem to be reasonable and not impracticable, and invites a full discussion of the subject. The problem is intricate, and perhaps on that account has failed to receive the attention it deserves, but the time has arrived when its

[1] David A. Wells, *The Theory and Practice of Taxation*, p. 395. 1900.

consideration can be put off no longer. The welfare of every State requires that it be faced. No other question concerning the woodlands of the country, save that of fires, is so important, and we shall make little substantial progress in the effort to induce private owners to maintain their forests until the present condition shall have been relieved, and the forests be so rated that they shall bear no more than their fair share of the cost of government.

It is true that the virgin forests of the South and West have not yet felt the burden of overtaxation to any great extent, but the cut-over lands do feel it. In all the older States, those wherein lumbering has greatly enhanced timber values, the tax levied upon standing timber is often a warning to the owner that he must cut it or run the risk of great loss, and when he has cut it the bare land is taxed so high that he is forced to abandon it.

A few attempts to correct the evil, through partial exemption, rebates, or bounties, have been made. But, though such measures may serve for a beginning, the real need is for laws that, recognizing the public utility of forests, adjust the necessary tax levies to the facts and conditions that govern tree growth, and to the long periods of time that are required to produce timber.

In general, it is assumed that taxes are imposed for the protection of person and property as well as for public necessities, yet rarely is the obligation extended to woodlands. The forest is not only allowed to go unguarded, but everyone may tramp and camp therein and do almost what harm he will. The common law and statutes relating to forest depredations are notoriously disregarded, and, though the conditions in some parts of the country have been bettered of late years, private forest and public suffers much damage from careless and malicious sojourners.

Under the common practice of intrusting to local officers the levying of taxes upon real estate, forests are assessed,

almost without exception, on the basis of agricultural land; that is, the land is estimated to have a certain value if cleared, and the standing timber is worth so much more, or is viewed as an encumbrance. The latter case is by no means rare in hardwood sections. In many instances, perhaps in most, the assessment is fair so far as the value of the property is concerned. In many others it is far too high, because the land is not fit for farming and therefore valueless except to grow trees. At the same time, the timber often has only a potential value, since it cannot be marketed for want of roads or some other temporary unreadiness. The argument is entirely apart from the admitted inability of many of the assessors to truly value woodlands, and who therefore resort to guessing, and from the quite general belief that in cases where the owner is a corporation or a nonresident with no local interests, the property may be taxed to the limit. These things are not to be avoided under any system. In short, whether the assessment be made fairly or unfairly, the forest is considered a form of property which should be realized on at the earliest possible moment, and the more it can be made to yield to the county prior to its extinction the better for the county.

One can easily understand the temptation that confronts the assessors in regions where everything is wanted — roads, schools, public buildings, to use the taxing power for present advantage, yet instances are plenty of communities established on the returns from forest property and utterly abandoned as soon as the original timber was all cut. The few farms that had been taken could not keep up the roads and other public works.

But the wisdom or unwisdom of raising a revenue once for all upon forests is only a part of the question. True forest land is not farm land uncleared, and a forest is not the crop of a season. The problem concerns itself chiefly

with those areas which in their nature are fit only for tree growth, and with a crop representing the accumulated investment of the owner for as many years as were required to bring the trees to maturity. If a man buy a mature forest, he acquires the investment of another; if he plants, or waits for a natural one to grow, he gets no return for many years. In either case, his forest serves the public by providing a common necessity — wood, and by the beneficent influences that it gives freely.

These considerations make it apparent that forests occupy, or should occupy, a separate place on the tax list; that they need to be treated differently from farms and town lots and mines. In fact, it will be necessary to show that growing trees should be considered personal property, not real estate, as they now are by practice or law in virtually every State of the Union.[2]

Without going deeply into details, a few instances may be given to show how the present methods tend to rid the forest owner of all but a temporary interest in his property, and, instead of encouraging the practice of forestry and the maintenance of the forests, put a premium on destructive lumbering.

A competent authority says that "in Wisconsin the taxes on forest property have been for years 3 cents to 40 cents per acre, without reference to changes in its condition or value."[3] Forty cents is not unreasonable for an acre of forest containing 20,000 feet of White Pine, since it represents a rate of but 4 mills if the stumpage is worth $5 per

[2] The language of the statute of Massachusetts is: "Real estate, for the purpose of taxation, shall include all lands within the State and all buildings and other things erected on or affixed to the same." The statute of New York declares, "The term land shall be construed to include the land itself, all buildings, structures, substructures erected upon, under, or above, or affixed to the same; all wharfs and piers . . . all trees and underwood growing upon land; . . ."

[3] B. E. Fernow, *Economics of Forestry*, p. 252. 1902.

thousand, but of course no owner would pay it after the timber had been logged unless he could reasonably expect to sell the land for farming. As a matter of fact, 37 per cent of the area of the State, once forested, consists of land too poor to be farmed, and may be bought for 25 to 50 cents per acre.[4]

The Forest Commissioner of Pennsylvania writes that on one of the few pieces of virgin forest still standing in the State, containing a little less than 1,000 acres, the annual tax is $2.83 per acre. If the whole tract average 20,000 feet per acre of White Pine worth $10 a thousand on the stump — both estimates are high, the tax is 1.4 per cent of the value, or, counting the assessed value at two-thirds the sale value, as is the common rule, the yearly tax is over 2 per cent, and the owner assumes all the risk of loss by fire and depredation.

The same authority states that denuded lands are commonly assessed at 50 cents to $1.25 per acre, and that the usual levies amount to 25 to 30 mills. This means a yearly tax of 1¼ to 3¾ cents per acre. If the soil is capable of agriculture the burden is not great, but much of it is absolute forest land, and the owners often prefer to surrender it rather than pay the tax. The State Forest Reserve Commission has bought at tax sales over 23,000 acres of such land for the accrued taxes and costs. In some cases these have been as low as 2½ cents per acre, though the average is somewhat higher. The commissioner instances one case where several parcels containing over 7,000 acres were bought in for a fraction over 8 cents per acre.

These figures are suggestive. They prove the passing of the forest in a State whose name indicates its original character, not entirely by the hand of the lumberman, but largely through the operation of its laws. They prove that

[4] Bulletin 16, Division of Forestry. Table II, and p. 54. 1898.

a county as a landowner is poorer than as the recipient of even a small tax on that land. They prove that there is much land unfit for agriculture which presumably will bear forest, since it already has done so. They prove that the State which has bought a forest reserve now amounting to 700,000 acres, and is still buying, and which has made many worthy efforts to advance the cause of forestry, has still failed to secure the co-operation of private owners to any great extent because it persists in taxing their lands, especially their cut-over lands, at a rate that is unreasonable.

In North Carolina conditions are not much different. The common levy is 1 per cent on a 60 per cent valuation, or 6 mills on the estimated value. Where this value is justly assessed, there can be no reasonable complaint, but there is much guessing, and in one county it is reported that land partly lumbered, or cut over as the forester advises, is taxed 25 per cent higher than virgin forest, on the ground that it is improved land. In other words, a penalty is imposed on conservative lumbering!

On the Pacific Coast a similar situation is found. The actual value of the great standing forests is undetermined and steadily growing, so that there is probably little overtaxing of virgin timber, but the burden on cut-over land is so great that large areas are relinquished every year. Some of this land may be taken up by settlers, but the rule is that when the counties become the enforced owners it remains unproductive, uncared for, and during the dry season a constant source of dangerous fires. A study of this question made in the State of Washington in 1900 developed the facts that in nine counties logged land was assessed 25 per cent to 50 per cent as high as that bearing standing timber, and that much of it was abandoned on that account. In two counties 20 per cent of the logged

land had been surrendered and in another 71 per cent.[5] A recent report from that section states that the sale value of logged land is rarely as high as the assessed value.

The figures given above will have more meaning, perhaps, if they be compared with what a forest can yield. Say that an acre of land produces in eighty years 7,000 feet B. M. of lumber, worth $49 on the stump,[6] and that a tax of 2 cents is paid each year. If money be worth 5 per cent, the 2 cents paid annually eighty times amounts to $19.42, or 40 per cent of the value of the crop!

In view of the facts that have just been stated, and of the very general interest manifested in forest preservation, it is reasonable to expect that the laws and practices of at least one State have been adjusted to the necessities of the situation. Unfortunately that is not the case, for, though many States have dealt with the subject within the past thirty years, not one has framed a law of the right kind. Connecticut exempts from tax for twenty years plantations of certain specified trees made on land not previously wooded; Wisconsin exempts shelter belts or wind breaks made and maintained in a certain way; Colorado, Indiana, Maine, Nebraska, New Hampshire, Pennsylvania, and Rhode Island give partial exemption on plantations or on *limited areas* of forest. None of the laws can apply to more than small woodlots. Illinois, Kansas, Wyoming, Minnesota, and Wisconsin give bounties for tree plantations, and Massachusetts, Minnesota, and Vermont offer premiums to encourage tree planters.

To these State measures is to be added the Federal act

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[5] E. T. Allen, *The Western Hemlock*, Bulletin 33, Bureau of Forestry, p. 37.

[6] This quantity is small for a plantation or for land that may be used as a farm, and the stumpage is low for localities where timber is scarce, or for select logs, but both figures are fair for large areas of ordinary uncared-for forest.

of 1873, known as the Timber Culture Law. This was intended to encourage tree planting on the public lands in the West, but was so abused that it was repealed in 1891.

The laws and practices of many States concerning the observance of Arbor Day evidence the desire and intent of the people to foster the growing of trees, but at the same time they prove the entire insufficiency of such measures to support one acre of commercial forest or to maintain existing woodlands for the common weal

In approaching this subject one naturally turns to those European countries in which forestry has become an art, for, manifestly, no oppressive burden of taxes could be bourne where the growing of trees is found to be so profitable. The conclusions from such a study are two: (1) That the systems of taxation are so radically different from ours that only general principles can be applied here; and (2) that the assessments are always based on the actual value of the forest, or on the earning power of the land, that is, its yield.

The first principle in all these laws is that the forest shall be considered and rated apart from the land upon which it stands. This principle finds universal acceptance, in theory at least, though the practice differs in the various countries, and is based upon the fact that a forest is a crop of many years' growth and represents the owner's savings — the accumulated capital and interest on a time investment. This fact is as obvious here as it is there, and in my opinion makes it necessary for us to admit that in any piece of forest property the soil alone is realty, the growing trees are reinvested income — that is personalty.[1]

To illustrate: A man has two fields. On one he raises

[1] The forests of the German States, for instance, are estimated to have 75 per cent to 85 per cent of their value in the timber and 25 per cent to 15 per cent in the land. M. Endres, *Forsten*, in Conrad's Handwörterbuch der Staatswissenschaften. 1900.

corn, and year by year puts the value of the crop in bank or buys securities, which he holds and on which he pays, or should pay, a personal property tax. On the second field he plants trees; they thrive and make a good growth, but at the end of the season they are not convertible into money as the corn crop was. So it is for many years. The tree crop is made each season, but must be left on the stump until enough wood is accumulated to make it salable. Suppose the farmer, instead of selling his corn, had put it into a crib and added the second and third and each succeeding year's crop to the first; would he not accumulate personalty in the crib of corn? He does the same with the product of his trees, but the result shows this difference: The crib of corn earns no increase; it represents only simple interest on the land; it is not like the money in bank that might have been obtained by selling the corn, which would earn compound interest by being reinvested with the accrued interest every year. In the growing forest, however, the increase in value is reinvested; the owner expects his trees to yield him a profit on the capital which they themselves represent, as well as on the capital which the land represents. But the two values — that of the trees and that of the land, are distinct.

It is thus evident that because the tree grower must reinvest his annual crop in stumpage it is no reason for considering it real estate. In the view that forests can be reproduced, trees are virtually movables, and the practice of rating them a part of the land is the fundamental error in every American State.

Theoretically it is as proper to tax growing grain as growing trees; but since the grain matures in one year, while the trees require many, and all our fiscal arrangements are based on annual returns, the trees should be taxed though the grain be exempt. Here, however, comes in the second principle in the taxation of forests; that it is

unjust to require the owner to pay so long as the forest yields him nothing. There is no equity in making a man's other property carry his immature forest. In practice this works out in various ways. Most of the German States have not yet made the principle effective, but Baden exempts newly established forests from tax for twenty years (law of 1886). In Austria they are exempt for twenty-five years (law of 1869). In France three-fourths of the land tax is remitted for thirty years.[8] In connection with these laws it should be remembered that forests in Europe begin to yield salable material when they are from 20 to 30 years old. In most parts of the United States the productive period begins later, because there is no market for small wood.

This principle of exemption or rebate is familiar enough in this country, where undeveloped property of all kinds is taxed at a nominal rate. Farm land not cleared bears little. A comparison can not be made, however, with other forms of unproductive property — city lots, for instance. The owner of the latter produces nothing from his land; he hopes to gain by what others do. The forest owner, on the other hand, does produce something of value and will eventually pay a proper tax on it.

One reason why forest property is held in such high esteem in most of the countries of Europe is that the taxes are levied fairly. No matter how high the rate in any locality may be, the owner has the assurance of absolute equity in the valuation.

It would be impossible to apply the European system here with anything like the exactness that attaches to it in the old countries, because we have not the means of knowing the true worth of forest soil or of forest crops, but the

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[8] M. Endres, *Die Besteuerung des Waldes*, in Forstwissenschaftliches Centralblatt, 1899, p. 509.

principle is applicable anywhere. Even in the hands of nonexpert assessors it gives a fairer basis of valuation than our present method, and in the long run will insure larger returns.

This is the equity of forest taxation; but the communities have another interest than that of revenue, namely, to maintain the forests in the greatest possible extent and effectiveness for the sake of lumbering and its many dependent industries, and for the influence that they have upon stream flow and the modification of climatic extremes. These subjects are beginning to be well understood, and need not be dwelt upon.

The points that in the writer's opinion, should be considered in any equitable scheme of forest taxation are the following:

(1) Forests are necessary to the public welfare, and consequently each Commonwealth should bear a part of the cost of maintaining them. This means that the State treasuries should assume a considerable part of the obligation, and, as far as is proper, relieve the counties, because a region that is rich in forest is poor in everything else — population, farms, industries, and it is right that the cities and towns should contribute to the maintenance of conditions that are as important to them as they are to the people who live close to the forest borders. Exemption and rebates, as usually allowed, do not meet this requirement, because the county bears the burden; that is, if one piece of property pays less, all the rest must pay a higher rate to make up the deficiency. In no case are exemptions justified, unless everyone who shares the burden of it is correspondingly benefited. If a piece of private forest serves to protect a drainage area, or is valued for its beauty, it is right for all who enjoy it to pay a proper share of the local taxes. For instance, if a town or village wants the owner of a woodlot to keep it for the people's pleasure

they may remit the taxes on it, because no one else is concerned.

But a State can not properly declare that its forest reserve shall be untaxed, because such action robs the counties of the revenue that they need. New York, which holds the largest State reserve, recognizes this principle and pays local taxes on its land. The Austrian state forests pay taxes on land and income. With our National holdings the same principle should apply in all cases where land previously subject to taxation is taken over.[9]

(2) A forest is a form of property whose value is potential or prospective most of the time; only when the trees are market ripe can an income be derived from it.

(3) In consequence of yielding periodic returns, the greater part of the tax to be paid upon a forest should fall due when the timber is sold, and not be made a burden upon the other property of the owner through many years. The periods at which forests may yield returns should not be considered as the full time required to grow the average tree; some trees mature much more quickly than others, and all natural forests contain trees of various sizes and ages. It is doubtful if any forest, containing the usual diversity in size or species, and now market-ripe, would not yield again within twenty years if cut carefully. This point is often overlooked, yet it is of great importance in considering the periods during which a given piece of forest would pay only the ground tax.

(4) The deferred tax should bear a fair relation to the net yield of the property; that is, it should not exceed a sum that will leave the owner the equivalent of a fair annual return on his investment.

(5) Forests occupying land of the kind here considered grow too slowly in most situations to yield by their annual

[9] Under a new law, enacted in 1905, Pennsylvania pays to the counties in lieu of taxes 5 cents a year for each acre of State land.

increment a rate of interest comparable with that commonly expected from ordinary business enterprises, though they may easily produce wood at a rate that will compare favorably with the interest derived from State or National obligations.

(6) Forests are exposed to unusual risks from fire and depredation, owing to their very general use by the public.

What are the objections that may be urged to a law embodying these principles? The fundamental proposition — that forests be assessed apart from the land upon which they stand, suggests a radical change in the tax system of most States; but forestry itself is radical and demands new methods. Apart from that the only difficulty is to fix the values of land and forest. If it be admitted that forest owners are entitled to special rates on such property on account of its public value, the constitution of no State is likely to prove a bar to the necessary legislation, since existing bounty and exemption acts evidence the power of the legislatures. But if such difficulty be encountered it probably can be overcome by putting forests into a special class for purposes of taxation. The real questions, then, are how to fix the value of a forest and how to provide for the collection of the tax at intervals. The problem is less difficult than it appears to be. If the land alone is made to pay a yearly tax on its actual value, determined by the assessors in the usual way, the county gets at least as much income as it would if the forest were not there.

Then let the whole question of timber value be determined by what it sells for, and base the forest tax on that. Everything that comes out of the forest must pay the accepted rate of tax. Of course, safeguards must be provided; intermediate yields as well as the main crop must pay their shares, a proper return of quantities and value of material sold or used must be insured, and provision made for an adjustment of loss in the event of serious

damage to the property by fire or storm. If theft is committed, it may be assumed that the county is equally responsible with the owner. The county being thus protected against loss, the owner on the other hand, must be assured that the rate will not be raised when it is known that his timber is ready for market. The deferred returns from this source would be viewed as sinking-fund accumulations, or they might be used as a basis for bond issues to supply special needs.

A law framed along these lines would, of course, have to be adapted to local conditions and practices. Its proper execution would involve some increase in the executive personnel, yet even without that the change could not fail to be an improvement on the present system.

It is difficult to illustrate this plan as applied to a forest already grown, but which may not be cut for several years, without accurate knowledge of the value of the stand and of local conditions. Perhaps it would be found safe and entirely reasonable, in most cases, to remit the taxes until the trees were cut and then collect a definite proportion of the net yield for each year that tax had been unpaid. The difficulty naturally is to determine what that proportion should be, and it can only be settled by applying the principle to concrete cases.

But it is possible to find an illustration in an example of a forest grown on ground that is now bare. Let it be assumed that 50,000 acres of pine land in Michigan, valued at $1 per acre, will yield, eighty years hence, 350,000,000 board feet of lumber, worth $7 per thousand on the stump. The figures are conservative, and if a young forest be already started on a portion of the area, so much the better. If the local tax levy is 2 cents, on a two-thirds valuation, the land will pay to the county 1⅓ cents per acre, or $666.67 per year. Then, if the State pay half a cent per acre on account of the public utility of the forest (see p. 125)

the county will receive $250 more, or a total of $916.67 yearly. In practice, the forest would begin to yield something after thirty or forty years, but for the sake of simplifying the calculation let it be assumed that it is all cut at the end of eighty years. How much of the sale price should the county get? The forest at 1 year old is actually worth nothing, hence no tax can properly be charged against it. At 2 years old it is nearer maturity, but still has only an "expectation value," based upon what the mature trees may yield. In short, the value increases year by year from nothing to $2,450,000, when it is 80 years old.

The values upon which a tax might be levied each year are thus difficult to determine, but an average may be assumed to be the expectation value of the forest when it is 40 years old. That is $2,450,000 discounted at 4 per cent for forty years, or $510,310. Then if exemption were allowed for the first thirty years the collectible tax would be the accepted rate paid on that sum for fifty years. It is manifest that the accepted rate can not be the same as that applied to the land — 2 per cent on a two-thirds valuation, for when continued fifty years the sum of the taxes amounts to nearly half the final value of the crop. Such a proportion is prohibitive, and it must be admitted that forests can not pay the high rates commonly levied on real estate — at least not until the crop is worth relatively more than it is now. This fact is strongly emphasized if we ignore all rebates and allowances and say that the forest shall pay 1⅓ per cent of its value yearly. Eighty times 1⅓ per cent equals 106⅔ per cent; in other words, the whole crop would not pay the tax.

For the purpose of the present illustration, it may be assumed that the rate is one-half of 1 per cent, and, again, that money is worth 4 per cent. The total return at the time the timber is cut will then be $389,537, or about 16 per cent of the stumpage price. It is possible that in some

cases the county might claim more. The figures in any event would depend largely upon the length of time involved; but bearing in mind the importance of encouraging the owner to keep his forest standing, the proportion may be accepted as about what should be paid. The county is distinctly better off than it would be under the present system, for, instead of uncertain returns or no revenue at all if the land were relinquished, it has the assurance of a reasonable yearly revenue from the land, and a lien upon the mature forest for a further sum which, discounted at 4 per cent, is equal to $706.65 a year.

This example does not pretend to be exact in any respect; it is purely illustrative; yet if the land value, the yield, and the interest rate be accepted as reasonable, the following table will show that both owner and community are treated fairly. If the owner's profit appear too small for the risk involved it should be remembered that no allowance is made for a very probable advance in land and stumpage values.

Comparison of tax collected and owner's profit from a forest of 50,000 acres yielding timber worth $2,450,000 after eighty years.

County's Interest	
Yearly revenue from land	$ 666.67
Yearly revenue from State	250.00
Yearly revenue from forest, calculated from final return	706.65
Total	1,623.32

Or practically 3¼ cents per acre = 3¼ per cent on a value of $1.

Owner's Interest	
Investment:	
Land at $1 per acre	$ 50,000
Capital to produce $666.67 yearly for land tax and $1,000 yearly for management	41,667
Total	91,667
Receipts:	
For stumpage	2,450,000
Value of land	50,000
Capital set aside to pay taxes and management	41,667
Gross total	2,541,667
Less deferred tax	389,537
Net total	2,152,130

Profit = 4 per cent (about) compound interest on the investment.

In conclusion, forest taxation is peculiarly a legal question which each State must consider individually and without interference from the National Government. Any enactment must harmonize with the fundamental law and do justice to all interests. Opposition to any measure is sure to be encountered, and for that reason a radical proposition has some advantages over one which, like an exemption act, would seem to favor a class. Emphasis needs to be laid upon the point that whereas the ability of most of the States of the Union to acquire forest reserves is limited by lack of revenue, those which contain the largest areas of private woodlands have the power above all others to keep the forest in those places that are naturally adapted to it.

From these considerations it appears that the actual situation can be met only by accepting a principle in taxation which shall definitely recognize the public value of growing forests and in its application strive to maintain them as the sources of material needed in important industries and as valuable climatic factors. This means that private property in forests should be taxed with reference to three considerations: (a) Necessity — the support of the local government; (b) equity — an assessment based upon the actual yield, collection of the tax (on the trees, not on the land) deferred until the crop is sold, and a recognition of the peculiar risks — fire, trespass, etc. — to which forests are subject; (c) encouragement — a special rating of the property to compensate the owner for whatever expense attaches to maintaining the forest in a condition that best serves the public interest.

WHAT ARE THE ESSENTIALS OF A STATE FIRE LAW?

E. A. STERLING

Delivered before the Society December 15, 1904

Attempts at State forest fire legislation are by no means new. Nearly all of the forested States have enacted various laws bearing directly on the subject, and the statutes in force aim to provide for more or less adequate protection of forests and woodlands from fire. The thoroughness with which these statutes cover the field, depends on when they were enacted, and the motives which prompted the action; on the understanding which the framers had of the subject; and on the earnestness of the legislators.

Since colonial days, laws against the willful or malicious setting of fires have existed, while sporadic and half-hearted legislation along lines of forest protection has appeared from time to time up to the present. Never until very recently, however, have comprehensive forest laws been adopted by any of the States. With a few exceptions, the laws enacted have not only been totally inadequate in their scope and purpose, but the few valuable statutes passed have remained inoperative through lack of officers responsible for their execution.

True, some of the States, notably New York, Maine, Pennsylvania, and Minnesota have gone farther and established fire-warden systems, but the reluctance of the legislative bodies to appropriate the needed funds has prevented the full development of any of the systems proposed. New York has been the most liberal of the States in matters of appropriation for forest purposes, and has had excellent machinery for the extinguishment of fires; but prior to the enactment of the recent, and as yet untried, amendments

to the forest code, it has been woefully weak in measures calculated to prevent fires.

It is unreasonable to expect anything approaching adequate forest protection from fire until the individual States are willing to make considerable annual appropriations for the purpose, a thing which most of them at present seem unwilling to do. The futility of mere statutes in the law books, without a complete system to back them, was seen in the case of Washington this last season. Forest-fire laws were enacted at the last session of their legislature, saddling fire-warden duties on various State and County officials, and imposing penalties. During the summer just passed the usual number of disastrous fires occurred, and, so far as could be ascertained, the newly-enacted laws were practically inoperative.

That it would be a paying business for States to invest in forest-fire protection does not need demonstration here. A thing which will help wonderfully in making State systems of fire protection successful will be the application of systematic plans of fire protection on limited tracts, by individual lumbermen and timber owners. That reasonable assurance of fire protection may be secured more easily on small individual holdings than in the diversified forests of a State or County is evident. Such protection must be given if forestry is to be really practised, and with improving conditions and the growing desire for applied forestry, the outlay necessary for the protection of small holdings need not be prohibitive. By small holdings, I mean the areas of varying size which are owned and under exploitation by lumbermen, and upon which individual or corporation interests are centered.

Properly, individual efforts towards fire protection should follow, not precede, State activity along these lines. It is the State's paternal duty, through wise laws and cooperative aid, to encourage and assist the individual to protect

his timber holdings from fire. By so doing, the protection, under State management, of all timber lands would be made much easier. The States, however, have been so delinquent in these matters that timberland owners, especially on the Pacific Coast, have been obliged to take the first step, and depend for the future on their own resources or the doubtful hope of State aid.

To come back to the subject as stated, I should say that the fundamental essentials of a State fire system are two: First, laws covering every possible point of danger whereby fires may start and do damage; second, the machinery to carry out such laws to the fullest possible degree.

The first would include all preventive measures, restrict the use of fire, and name penalties for violations of the fire laws. The second would provide for the strict enforcement of these preventive statutes, fix the responsibility, and secure prompt action in suppressing the fires which, through accident or design, are bound to start, despite the strictest regulations.

Since my field of action in matters of forest-fire legislation has been centered in California for some time, it will probably be best to try to tell you of our attempts to embody these principles in the proposed forest code of that State. These principles, modified to suit local requirements, would have equal working value in other States.

The points of danger which we have tried to cover by laws in California are several, and are based on a study of the causes of fires.

First in the list of general causes come campers, for, strangely enough, the people who derive the most pleasure from the California forests do the most harm to them. Under this heading come hunters, fishermen, tourists, and all classes who come temporarily into the woods for health or pleasure. Lack of judgment in building camp fires, and carelessness in leaving them unextinguished, give rise to a

great number of fires. A smouldering pile of ashes, which in the morning looks perfectly harmless, is liable before noon to be fanned into life by the wind which usually rises toward the middle of the day. Many well-intentioned people are deceived, and think a dash of water is sufficient to extinguish a pile of coals.

The proposed law will make it a misdemeanor to even leave a camp-fire unextinguished, and provides a fine of from $50 to $500, with costs of suit and collection, for a violation of the provisions imposed. Moreover, half of the fine, or so much thereof as does not exceed $50, goes to the person securing the arrest of the offender. The better classes of people are wide awake to the dangers from campers, and even without State fire-wardens there would be good results from such a law.

Careless burning of brush in clearing land, summer blasting of wood in the grassy foothills of the middle Sierras and southward, and the setting off of fireworks in the dry season, are causes frequently productive of disastrous fires. The most expensive fire the Government has been called upon to fight in southern California since the reserves were created was started by a burning fuse blown into the brush while splitting wood with the aid of powder. It is hoped that these dangers will be averted by making a close season, from May 15 to the first soaking rains of autumn, during which time it shall be unlawful to set fire save after written permission is obtained from the District Fire Warden; making exceptions, of course, in the case of the fires used in connection with redwood logging, and for back fires and camp fires.

Willful, malicious, or careless setting of forest fires is covered by a broad statute imposing a severe penalty, similar to those in force in several other States.

The section requiring the use of spark arresters on engines and locomotives, and the use of fire boxes and ash

pans of a pattern which will prevent the escape of fire, contains no new features, save the exception made for oil-burning engines. Since practically all of the locomotives running through forested land burn oil as fuel and rarely set a fire, it was not deemed necessary to require the clearing along the right of way which New York State has found essential. There was also danger that the railroads would so strongly oppose the bill, if compelled to clear their rights of way, that it would fail of enactment. As the law now stands, railroad companies along their lines of road, and counties along the county roads, shall, when so directed by the State Forester, remove all brush and inflammable material in a manner and to an extent prescribed by him.

In a State as large as California, and with a dry season lasting through the greater part of the year, it is impracticable for the State to attempt a patrol of the forested lands. Provision is made, however, for the State Forester to maintain a fire patrol in times or places of special danger, or whenever it is deemed essential for the public interests, half of the expense to be borne by the State and half by the county in which the patrol is maintained. He may also establish a patrol upon private land when so requested, in which case two-thirds of the expense shall be borne by the party making the request, the remaining one-third to be paid by the State.

The question of compulsory slash burning was one which received most careful consideration. Although one of the greatest forest problems in California, it has not been deemed advisable to make it a subject of legislative action at present. Several prominent men, including the head of one of the largest lumber companies in the State, urged general compulsory burning of slash. The ground for this was found in the argument that it was useless for a large company to burn slash extensively if the smaller owners

adjoining left unburned slash to menace the surrounding property. In view of the impossibility of properly regulating slash burning over a whole State, of the expense, of the lack of knowledge as to the best methods, and of the strong opposition which such a measure would arouse, it was decided to keep the subject out of the legislature at the coming session. By making burning compulsory only upon order of the State Forester, the desired results would still have been within reach. This, however, would be sure to result in more or less pressure being exerted by influential parties in order to prevent or secure burning, and would add to the Forester's authority, which is quite sufficient without this addition.

Second only in importance to the framing of fire-preventive measures is the placing of the responsibility upon proper officers and the arrangement of a system which will secure the rigid enforcement of the laws, — in short, the machinery of the State forest-fire system.

The officers upon whom will devolve the responsibility of enforcing the proposed State fire laws are: the State Forester, who is also Chief Fire Warden; the Assistant State Forester, who is Assistant Chief Fire Warden; ten District Fire Wardens; and an indefinite number of voluntary Fire Wardens scattered throughout the forested regions of the State. The voluntary Fire Wardens are to be paid 25 cents per hour for the time actually employed, provided payment in any one year shall not exceed $50. The District Wardens are to be salaried men, with expenses, half of the total expense to be borne by the counties composing the districts, and half by the State.

The general scheme can best be explained by starting with those lowest in rank and showing how the different grades are related.

Voluntary Fire Wardens will be appointed throughout the forested sections, in numbers depending on the avail-

able men and the needs of the region. Our investigations have shown that there are good men in every district who will be willing to assume the responsibilities of such a position. They are usually property owners and thus have a personal interest in fire protection. In the past it has been no one's business to put out small fires or call out men to fight large ones. The severest fires in California have resulted from small fires which smouldered for days and could easily have been extinguished at the beginning. It will be the definite business of the voluntary Fire Wardens to see that smouldering fires are extinguished, larger ones fought by an ample force, and the fire laws obeyed in their neighborhood. Penalties are attached for neglect of these duties, and over all of the voluntary Wardens are District Wardens, who enforce all rules and laws. The District Wardens will travel continually through their respective districts, and, in addition to their supervision of voluntary Wardens, will carry on an educational campaign, see to the general enforcement of the laws, prosecute for violations, and act as general mediums for carrying on the lines of work planned by the State Forester. Ranking the District Wardens is the Assistant Chief Fire Warden, who will spend most of his time in the field, supervising the work of his assistants and carrying on co-operative work. In general charge is the State Forester. By this arrangement, each fire warden is under the supervision of an officer of superior rank who will insist upon a compliance with fixed regulations, and place the responsibility in case of neglect; while the appointment of a large number of voluntary wardens to act under the direction of traveling District Wardens will give a large, efficient field force at the minimum of expense.

A weak point in fire protection on California reserves has been the inability of reserve officers to enforce their rules on private land in or near the reserves. The proposed

forest bill will give the supervisors and rangers State authority to arrest without warrant, violators of the fire laws. This should result in better protection of both State and Federal land.

Opposition to this general plan for a State fire system was made on the ground that railroad companies and rich corporations need not spend a cent in protecting their holdings, but may leave everything to the State. In order that individuals and corporations may bear their share of the responsibility and exercise the greatest care in the use of fire, it was provided that: "Persons or corporations causing fires by violation of sections 15, 16, 17, or 18 of the Act shall be liable to the State in an action for debt, to the full amount of all expenses incurred by the State and counties in fighting such fires."

Having decided on the essentials of an ideal forest bill, it remains to get as much of it as possible through the legislature. There are bound to be important points which must be eliminated because of local political conditions. What is favored or wanted in one section will be opposed in another. As soon as a proposed bill is given to the public, the life of the author becomes one long round of explanation.

It is of course impossible to say whether or not the forest code proposed for California will pass the legislature.[1] It is almost certain to be changed more or less, and some of its best features may have to be sacrificed in order to get anything through. Everything now depends on the Forestry, and Ways and Means Committees of the Legislature, and their willingness to accept the bill upon the explanation that its various provisions are essential if anything approaching adequate protection from forest fires is to be enjoyed by the State. The encouraging features are that

[1] The bill, somewhat modified, became a law March 18, 1905.

the forest sentiment throughout California demands action; that the present administration favors the bill; that there is no organized opposition; and that those in closest touch with the legislative body say that the possibilities of passing an ideal forest bill are better now than ever before.

DEFORESTATION IN CHINA

BAILEY WILLIS, U. S. GEOLOGICAL SURVEY

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China, like other long inhabited lands, has been deforested wherever the conditions of climate or topography are not such as to make it impossible to destroy the forest. In this respect the empire divides naturally into a southern region on the one hand, in which semi-tropical conditions of rainfall and temperature are exceedingly favorable to vegetation, so that shrubbery and trees have renewed themselves wherever there is opportunity; and on the other hand, northern China, where severe winters and limited rainfall are unfavorable to growth, and the great need of mankind for fuel has rendered his destructive activity especially effective.

In central China there lies between the north and the south a great mountain range, 8,000 to 12,000 feet in altitude and approximately 300 miles across, which, stretching east and west, separates provinces as distinct as are those on opposite sides of the Cascade Range in Washington. In this great mountain range, the Ts'in-ling-shan, there is a meeting of the vegetation of the temperate and semi-tropical zones. In the more southern and lower valleys one finds the bamboo, growing in a single season to heights of 30 and 40 feet, the Chinese sumac or lacquer tree, and varieties of the araucarian pine, together with many trees and shrubs unfamiliar to an American; but ascending the mountains, one passes up into extensive coniferous forests, where trees as much as five feet in diameter and perhaps 200 feet tall may still be found. One would scarce perhaps credit the primitive methods of lumbering employed by the Chinese, with ability to destroy the forests of a densely grown moun-

tain range, but such is the case. Along the more accessible foothills, shrubbery or bare hillsides replaced the forest which we were told flourished there within forty or fifty years. Villages, whose prosperity had depended upon the lumbering industry, contained many deserted houses, which, in their ruinous condition, reminded one of an abandoned lumber camp of our own Northwest; and the steep slopes from which the soil was rapidly being washed in deep, red gullies told how recent had been the removal of the protective forest cover. Yet here the only implements of destruction are a primitive axe and saw, and the only means of transportation for the lumber is men's backs. The trees are commonly cut with a small axe, and are sawed with a whip-saw into boards two and a half to three inches thick, with an average length of eight feet. Three or four such boards make a man's load, and are carried out, it may be a journey of ten days or two weeks, over the roughest mountain trails, by men whose average day's journey is ten to fifteen miles, and who crawl over the path, steadying themselves under a load of 180 to 200 pounds by carrying in each hand an iron-shod pole. The use to which these boards are put is limited to the single purpose of making coffins. Usually an entire coffin, consisting of a top, bottom, two sides and ends, all shaped and hewn to be put together, makes two men's loads. Small logs, which are used for house building and other purposes, are sometimes run in streams, and the Chinese then use a stout canthook and methods not unlike those of our own lumbermen in mountain regions.

The use of posts and beams for the better houses and temples is general throughout China, and second-hand beams are commonly sold. They consist of tree trunks stripped of their bark and somewhat smoothed. A post of this kind 30 feet high is of very unusual dimensions and the cost is correspondingly great. In a new temple at one

of the great monasteries, to which the Empress Dowager had given largely, the posts averaged 30 odd feet in height and were covered with red lacquer which concealed the undressed surface. There were about twenty of them and their cost had been a very considerable part of that of the entire structure. How such trunks are obtained and transported I do not know, as I did not see any lumbering operations in progress. They must be brought from a long distance by the most primitive methods.

In north China, lumber is a very rare commodity. The severity of the climate creates a demand for fuel, which long since exhausted the natural supply and drove the people to ingenious expedients for burning twigs and grass. Sticks of wood an inch in diameter and 8 inches to a foot long are to be had, but their cost is beyond the reach of any but the well-to-do. They are obtained by cutting off branches of quick-growing trees. Huge bundles of brush are brought in by the mountain men, who gather them on the least accessible mountain summits; and charcoal, made in districts of scanty population where willow and other underbrush has a chance to grow, is the common fuel of those who can afford the luxury. But the average farmer of the country burns grass or stubble. The grass is gathered by boys, who are sent out to crop it with sharp, crooked knives with which they scratch it up by the roots from among the rocks of the mountain sides. One will meet groups of the little fellows working like beavers several miles from their villages, up on the heights where there is not sufficient soil to justify the farmers in building terraces on which to plant a crop.

It seems as though the two great needs, that of food and that of warmth, here come into competition. To supply food every square yard of arable land is tilled, and the soil from slopes which can not well be cultivated is gathered on terraces and there made to yield a crop. By building walls

and scratching the surface a system of terraces is carried high up on the mountains, and there seems to be scarcely any place where grass or shrubbery can grow for fuel. (See Fig. 1.) But there are some hardy grasses and some shrubs which the most persistent rooting will not destroy, and among these the people gather their crop of fuel. The fields yield stubble and not a scrap of it is lost. When the harvest has been gathered and the fields look bare, at least to a foreigner's eye, the Chinese goes over them with an automatic rake, which not only rakes but gathers into itself every blade of dry grass or bit of corn stalk. He walks along with the handle hanging over his shoulder, and leaves a perfectly bare track about 30 inches wide, the width of the rake, behind him.

In the rich province of Shan-tung, one of the eastern provinces of the Empire, which has been occupied by the Chinese for more than four thousand years, this process of soil gathering and of destruction of all vegetation except that which is grown as a crop, has progressed almost to its ultimate limit. Yet it is evident, from the old and vigorous trees which are found in the villages and in the temple grounds, that the climate is a favorable one for willows, cottonwoods, and elms, or trees which resemble them in generic character.

A still more striking instance of deforestation is found in the mountains of northwestern Chi-li, where the altitude of the valleys is 4,000 feet and the broad flat summits rise to 10,000 feet. These mountains have been occupied by wandering peoples and traversed by caravans for several thousand years. They harbor many monasteries of Buddhist priests, established since the introduction of Buddhism in China in the year 68 A.D., but a good growth of coniferous forests, of which a few remains are still to be found in remote gulches, is said to have covered the mountains up to the time of the Emperor Kang-hi, the first of

FIG. 1. DEFORESTED AND TERRACED MOUNTAINS IN THE PROVINCE OF SHAN-SI, NEAR THE CITY OF WU-T'AI-HIEN, NORTH CHINA.

the present Manchu dynasty, 1665 to 1723. Kang-hi made several pilgrimages to the central shrine of Buddhism in these mountains, Wu-t'ai-shan, and conceived the idea that it would be well to populate the district with immigrants. He allowed the people whom he induced to settle there to cut the timber, and they probably found in it a good source of revenue for the time being. They did their work thoroughly, — so thoroughly that at present one looks out over mountain summits absolutely bare of vegetation, and one travels through valleys choked with the debris of torrents. In something less than two hundred years the aspect of the region has been utterly changed from one which old Chinese writers described as abounding in forests, with many springs and running brooks, to one in which there is scarcely a stick to be had. Living streams are found only in the larger valleys, and all the mountain slopes are scored with deep and ragged gullies. The condition has passed the help of man or nature, and it is rather a question of decades than of many centuries, before the soil will have disappeared and the mountains will stand out in utter nakedness.

In southern China, where the needs of man are few and where the luxuriant bamboo supplies most of them, trees continue to grow. In northern China, where the demand for wood is great and the climate is adverse, there is no longer any forest. Individual need has been indulged at the expense of public weal, and in the absence of any public opinion or reasonable foresight, the natural supplies have been exhausted and the forest laid waste.

There is but one saving clause in the situation, which, though it does not affect the forest, does modify the results of the forest's destruction. As they laid bare the mountain slopes the Chinese realized, probably at a very early date, that the fields they cultivated where the trees had grown were being swept away. They learned the art of building soil reservoirs — that is of terracing, and have be-

[illegible] the streets is that which the mountains [illegible] [illegible] [illegible]

CHAPARRAL AS A WATERSHED COVER IN SOUTHERN CALIFORNIA

L. C. MILLER

Delivered before the Society February 9, 1905

There is no part of the United States where the question of watershed protection is so clearly understood as in the great Southwest. There is no one section of this vast territory where this question is more universally understood than in southern California. This understanding is an outgrowth of the careful study of necessities. Economically speaking, water is the greatest necessity in southern California. The extent and rapidity of development is largely depending on the amount of available water.

Watershed cover in the southern California mountains can be divided roughly into three classes: first, pure chaparral; second, chaparral with clumps of trees scattered through it; and third, an open stand of coniferous forest at the high altitudes. A large number of the tributaries of important streams are fed from the first and second classes, while the main branches may be dependent upon all three classes.

The regions which most vitally concern the people of southern California are the San Gabriel, the San Bernardino, the San Jacinto, the San Rafael, and the Cuyamaca mountains. The greater portion of each of these mountain ranges, with the exception of the Cuyamacas, is included within the Federal Forest Reserves, and the creation of a million-acre reserve in those mountains is of the utmost importance to the whole of San Diego County.

In the San Gabriel Mountains there are two important streams, the Los Angeles River with a drainage area of 567 square miles, and the San Gabriel River with a drainage

of 512 square miles. The watershed of the former, including all its tributaries, and that of the latter, except the upper part of the main branch and portions of two of its tributaries, the West Fork and Cattle Canyon, are in the first and second classes.

The Santa Ana is the principal river of the San Bernardino Mountains. This is the most important stream in southern California as it is being utilized for power more extensively than any other. It has a total drainage area of 1,540 square miles and a mountain drainage area, above Colton, of 351 square miles. Sixty-five per cent of this area is chaparral covered, the remainder contains scattering timber.

There is only one important watershed in the San Jacinto Mountains, — that of the San Jacinto River. It has a total mountain drainage area of 175 square miles, at least seventy-five per cent of which is chaparral covered, while the remainder supports a fair, second-class coniferous forest.

The San Rafael Mountains lie north of Santa Barbara; in places spurs of this range extend to the ocean. The Santa Ynez is the principal river. It has a total drainage area of 836 square miles, ninety-five per cent of which is covered with chaparral.

The San Diego watershed embraces portions of the west slope of the Cuyamaca Mountains and has a total drainage area of 400 square miles. The mountain drainage area is about 200 square miles. The chaparral cover is extremely poor, and for that reason the supply of water is deficient. There are some excellent storage reservoir sites in the Cuyamacas but their successful utilization is dependent upon the improvement of the watershed cover.

In this discussion "chaparral" means all species which go to form the stand of brush commonly found throughout California. It varies in density and composition according to geographical and altitudinal range. There are three main

factors which affect chaparral composition; namely, aspect, soil, and altitude. Next to altitude, aspect determines very largely what sort of growth is to be found in a given locality. Temperature and precipitation are additional factors which exercise much influence on composition. In localities where the precipitation is alike on all slopes, there is to be found a difference in the number of species on north and south slopes. There is not only a difference in number, but there is a decided difference in height and density. This may all be attributed to a difference in temperature, but in a broader sense it must be attributed to protection. What this protection involves is obvious, and need not be discussed. The most careless observer can and does detect the difference and usually gives a simple but correct reason for it.

In southern California there are about 56 species which form the chaparral stand. Of these there are comparatively few of much value. The following are the most important:

Common Name	*Botanical Name*
Highland oak	*Quercus wislizeni* A. de C.
Scrub oak	*Quercus dumosa* Nutt.
Hollyleaf cherry	*Prunus ilicifolia* (Nutt.) Walp.
Simple-leaf sumach.	*Rhus ovata* Wats. *Rhus laurina* Nutt.
Manzanita	*Arctostapholos glauca* Lindl. *Arctostapholos tomentosa* Pursh. (Dougl.)
Buckthorn	*Ceanothus sorediatus* H. & A.
Wild lilac	*Ceanothus hirsutus* Nutt.
Christmas-berry	*Heteromeles arbutifolia* (Poir.) Roem.
Greasewood	*Adenostoma fasciculatum* H. & A.
Ceanothus	*Ceanothus crassifolius* Torr.
Wild buckwheat	*Eriogonum fasciculatum* Benth.
Lotus	*Lotus glaber* (Torr.) Greene.

Just what quantity of any given chaparral species is totally destroyed by fire can not be ascertained, for after fire has consumed the top it is difficult to tell from the dead stub what species was killed, and so the only way to get at the destructiveness of fire is to make note of the percentage destroyed without taking into consideration the species. It is the opinion of many that chaparral is not injured by fire, and that no matter how often the slopes are burned over the stand will not be lessened in the least but will "spring up with renewed vigor." This opinion is based on general observations, and, like all other such opinions, is inaccurate and can not be relied upon. The vitality of chaparral is greatly lessened when burned and it is frequently killed. Some of the species are more fire-resisting than others, however. For example, a greater number of dead stubs will be found on a slope where Greasewood and *Ceanothus crassifolia* form the greater part of the stand than on a slope where the greater part is of Scrub Oak and Buckthorn.

The density and character of cover are extremely important. Both of these factors have an influence on the water supply because all vegetation helps to retard evaporation.

The vegetation which borders the streams in southern California is very similar throughout the entire region. Within the same mountain range there is little or no type change in passing from one watershed to another. Some species that occur along a stream at the base of the mountains disappear near the head, and trees and shrubs occur at the head of a stream that do not occur farther down. There are some, however, that are persistent throughout the entire length. For example, the Alder (*Alnus rubra*) borders the streams from one end to the other. The Western Sycamore (*Platanus racemosa*) and various willows are also widely distributed along the courses of all streams. There is considerable difference of opinion as to the real value of this river-bank growth. Some advocate its entire

removal on the ground that vast quantities of water are taken up by the roots of the trees that otherwise could be utilized for farm crops. The advocates for the retention of the cover claim that the amount of water lost by evaporation from an unshaded water body far exceeds the amount consumed by the trees, and therefore, such a cover is of vast importance in equalizing stream flow and should be perpetually maintained.

The density and character of chaparral cover varies on different slopes, and with difference in altitude. The tendency for north slopes to support a more perfect stand is clearly demonstrated throughout the southern California mountains. In making surveys of chaparral stands, careful notes were made as to the density on different slopes at altitudinal intervals from 2,000 to 3,000 feet, and from 3,000 to 5,000 feet. This detailed work was carried on in the San Gabriel and the San Bernardino Forest Reserves and the results are given in the following table:

DENSITY OF CHAPARRAL STANDS IN PERCENTAGES

Number of Survey	PASADENA WATERSHED								SANTA ANA WATERSHED							
	ASPECT								ASPECT							
	NORTH		SOUTH		EAST		WEST		NORTH		SOUTH		EAST		WEST	
	ALTITUDE		ALTITUDE		ALTITUDE		ALTITUDE		ALTITUDE		ALTITUDE		ALTITUDE		ALTITUDE	
	feet 2-3000	feet 3-5000	feet 2-3000	feet 3-5000	feet 2-3000	feet 3-5000	feet 2-3000	feet 3-5000	feet 2-3000	feet 3-5000	feet 2-3000	feet 3-5000	feet 2-3000	feet 3-5000	feet 2-3000	feet 3-5000
1	85	80	60	25	50	20	60	75	45	70	35	60	40	50	65	50
2	75	60	70	75	85	95	70	90	75	75	20	70	55	50	40	60
3	80	40	40	50	70	60	35	70	75	55	20	70	80	30	55	50
4	90	70	80	..	50	85	65	40	60	50	35	50	50	85	60	50
5	..	60	85	95	60	85	60	90	30	50	30	60	55	70	50	60
6	90	60	50	60	65	90	40	35	90	50	40	50	40	60	40	70
7	..	55	65	80	..	50	50	90	60	90	25	50	30	65	50	65
8	..	85	35	90	..	90	90	90	75	60	60	25	50	..	30	70
9	..	60	35	90	..	100	70	40	..	60	40	35	70	..	60	65
10	..	95	60	85	..	65	30	80	..	40	20	50	45	..	35	40
11	..	65	50	70	..	80	35	60	..	75	60	60	40	..	60	..
12	..	..	75	00	..	..	65	55	..	35	40	40	60	..	45	..
13	..	..	50	45	..	..	55	90	..	70	70	60	30	..	70	..
14	..	..	20	80	..	..	90	45	..	..	50	..	60	..	35	..
15	..	..	80	80	..	..	75	..	..	..	..	..	50	..	45	..
16	..	..	..	75	..	..	80	..	..	..	..	..	55	..	50	..
17	..	..	..	30	..	..	..	..	..	..	..	..	..	..	40	..
18	..	..	..	..	..	..	..	..	..	..	..	..	..	..	30	..
19	..	..	..	..	..	..	..	..	..	..	..	..	..	..	60	..
20	..	..	..	..	..	..	..	..	..	..	..	..	..	..	70	..
21	..	..	..	..	..	..	..	..	..	..	..	..	..	..	40	..
Average density	84	66.3	57	70	63.3	74.5	60.6	67.9	63.7	60	38.9	52.3	50.6	58.6	49	58

The facts brought out by these figures are:

1. The density of chaparral increases upon ascending from the lower zone (2,000 to 3,000 feet) to the upper zone (3,000 to 5,000 feet) on the east, south, and west.

2. The density of the cover on north exposures decreases upon passing from the lower to the higher zone.

It is interesting to note that the density relations hold true for both the Pasadena and Santa Ana watersheds. In both these watersheds the density of chaparral is less on the west than on the corresponding east exposure. The figures corroborate the conclusions reached through general observation. From the observation of these facts one naturally seeks a reason for this difference in density, and it seems that it can be rightfully attributed to three causes; namely, fire, aspect, and soil condition. On north, and in fact on all shaded slopes, fire is about the only agency that tends to decrease the density of chaparral. The south slopes have, in addition to fire, to contend with exposure to intense heat and poor soil conditions. It can be readily seen why there is such a striking difference in the growth on these two aspects. Fire can not do such permanent damage on north slopes for the reason that very soon after the fire the repair of such damage is immediately begun. Conditions are most favorable in such situations, and the recovery is on the whole successful. Soil conditions differ widely on north and south slopes. The poorly covered south slopes are subjected to much greater erosion and there is little opportunity for species to accumulate leaf litter, and instead of the cover conditions being improved they are impaired. Thus it is that exposure and soil condition are two factors which aid in bringing about differences in chaparral density.

There is a constant struggle between timber and chaparral, but careful observation fails to show that the timber areas are increasing very satisfactorily anywhere in the

southern California mountains. The regeneration within the timbered areas is generally good, but the tendency for timber species to encroach on the adjoining chaparral areas is extremely unsatisfactory. The best example of the encroachment of coniferous species on chaparral found anywhere in southern California is at the summit of Mount Gleason in the San Gabriel Mountains. Here the mature yellow pine trees have seeded an adjoining south slope which is covered with an exceedingly dense stand of buckthorn. If this were the rule rather than the exception, the matter of reforestation could be looked at more hopefully, but when we find this condition restricted to an extremely small area the question of natural reforestation becomes all the more complicated. There are any number of places throughout the country where groups of Spruce, Pine, and Oak trees are distributed through the chaparral stand. The size of these groups varies from many acres in extent to a dozen or more trees. Often individual specimens of some species occur long distances from any tree, or group of trees, of its own kind. These conditions are most favorable for the extension of the forest, because the distribution of seed is not interfered with in the least. If the extension of timber does not take place under the above conditions, the failure can usually be attributed to fire, exposure to excessive dry weather, and the destruction of seed by animals. It is characteristic of chaparral species to extend to, and even beyond, the edge of the timbered area. Sometimes the demarkation between chaparral and timber is extremely noticeable. This is true of timbered areas above the typical chaparral zones, but it is not true of timbered areas which occur interruptedly distributed through this zone.

The limited water supply from mountain streams in southern California has brought about water development in various ways. Extensive work has been done in boring wells which has resulted in the discovery of vast quantities

of ground water. But in many places the supply has been drawn upon so extensively that where flowing artesian wells once existed, pumps must now be used to raise the water to the surface. This supply therefore shows evidence of exhaustion. With this problem before them the people of southern California have for some time realized that something must be done to sustain their present water supply, and, if possible, increase it. How this is to be brought about has been set forth by State and Federal authorities in reports, and in magazine and newspaper articles in which they recommend the protection and improvement of watershed cover. This plan has many enthusiastic supporters throughout the State.

There is not a single drainage basin in southern California that does not stand in serious need of improvement. This need is far reaching. The maintenance of the present, and the assurance of a future, water supply is depending upon it. There are two methods by which this needed improvement can be brought about. First, by providing for more efficient fire protection, which includes a system of well-built fire lines on all prominent ridges, a series of trails leading to now inaccessible points, and a permanent and efficient patrol force. Second, by planting desirable timber and chaparral species on poorly covered slopes.

Protection from fire is extremely necessary in improving the cover condition of watersheds. Therefore, fire protection is essential to the solution of the forestry problem of southern California. The great necessity for more efficient protection is fully realized when it becomes necessary to transport men, tools, and provisions to a fire which is raging in the interior of the mountains. At present the whole force must be taken over poorly kept trails to the scene of the fire. When once there, it is necessary for the men to cut their way through brush and timber in order to get in a position to check the fire. While this preliminary work

is being done, the fire is growing in extent, and perhaps in fierceness, and when the vantage point is reached the fire is in all probability uncontrolable, and the efforts have been fruitless. If a proper fire protection system were in operation, the time lost in cutting the way through brush and timber would be saved and the vantage point reached in time to stop the fire. In view of the fact that there is so much danger from fire and the annual loss is so great, it seems that the forestry policy which California should adopt and carry into execution should embrace a carefully planned fire protection system, which can be applied to, and put into execution in, all parts of the State. The law passed by the California legislature in March, 1905, provides for this, and there seems to be no reason why a first class fire protection system should not be perfected. There is urgent need for immediate action in watershed improvement through fire protection. The Federal Government will not be in a position to carry out these plans as rapidly as is to the best interests of the State, and therefore the State should cooperate with the Federal Government in establishing a fire-protection system for watersheds that most seriously need protection. Many of these watersheds are included in Federal Reserves, but if immediate improvement is to be brought about, it will be necessary for the State to contribute funds for operation in these Reserves. Owing to the fact that so many of the California cities depend upon mountain streams for their water supply, it seems that they can do a vast amount by cooperating with the Federal and State Governments in establishing a fire-protection system. The State must necessarily apply its funds in various sections as its object must be far-reaching. It can not apply its support to one region to the exclusion of another. Its policy must embrace the entire State. This being true there is presented an admirable opportunity for local work by cities and communities. There is not a city in the

State but what expends thousands of dollars annually in improvements of one sort or another. Some cities in the southern part of the State, especially Los Angeles and Pasadena have already extended their improvement policy to embrace their watersheds. Both of these cities have contributed funds to assist in carrying on reforestation work in the San Gabriel Mountains.

If it is expedient for the State and Federal Governments to improve watersheds by providing protection from fire, then it is likewise expedient for a city to consider the same question. *The question of protection must be solved before successful reforestation can be carried out.* Therefore, instead of recommending that cities and corporations expend large sums of money for actual reforestation, it would be more profitable for them to direct their attention to protecting watersheds from fire. Any amount contributed for tree planting aids very materially in conducting these experiments, but if the same or a greater amount were used in establishing a fire-protection system the immediate results would be of vastly greater value.

The advisability of cities making annual expenditures of several thousand dollars for providing protection from fire within their limits is never questioned. It is an indispensible factor of progress, and a city without this provision will soon cease developing and sooner or later be totally destroyed. It is hoped that during the next few years the much needed fire protection system will have been inaugurated, and that experiments will prove that planting timber and chaparral species on the mountains of southern California is a possibility. This having been done, it then remains for the State and Federal Governments and the municipalities to push the work of reforestation vigorously.

WHY PRAIRIES ARE TREELESS

ALFRED GASKILL

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The theory that prairies are made by forest fires is by no means new, yet none of those who have advanced it[1] furnish the evidence that is thought necessary to establish it as at least a reasonable probability. In consequence, most writers treat the idea with scant courtesy, or ignore it entirely, and, since none of the other theories is acceptable, consider the problem still unsolved. I think, however, that from the many investigations that have been made in recent years along various lines — geological, physiographical, climatological, and silvical, it is now possible to gather facts that, to me, are strongly indicative of the fire origin of all true prairies.

I propose to consider first the prairies of the United States, and then to see what points of similarity there are in other reigons of the world where a like problem is presented.

At the outset a distinction must be made between prairies and plains. The juxtaposition and gradual merging of the two types in many localities, and their similarity of aspect, have tended to confuse the situation and make an interpretation of the conditions more difficult. The word prairie, in scientific as well as popular language, often has been indiscriminately applied to any area relatively level, covered with grass and with few or no trees; but it is now

[1] C. S. Sargent, in Tenth Census of the United States, 1880, Vol. IX, p. 5; N. S. Shaler, in *The Origin and Nature of Soils*, Twelfth Annual Report U. S. Geological Survey, 1891, p. 323; H. Mayr, in *Die Waldungen von Nordamerika*, 1890, p. 223; and several others. Various authors also *suggest* fire as the active agent in preventing tree growth in other regions.

quite generally agreed that a difference must be recognized. Plains are treeless, and their vegetation limited to grasses and hardy shrubs, primarily because of deficient moisture. Where that condition is found, there is no evidence that trees ever did grow, and they do not thrive when planted unless the soil is cultivated. Prairies, on the other hand, do offer conditions favorable to tree growth; on them plantations are easily maintained, and natural forest finds frequent opportunity to extend its borders. The problem therefore concerns itself entirely with the latter, although, as I shall try to show, the peculiar conditions on the plains are what made possible the extension of grassy areas into forest territory.

Before offering the evidence in support of this theory, it will be well to consider the other suggestions that have been made relative to the origin of prairies.

1. J. W. Foster is chiefly responsible for the belief that the prairies were caused by insufficient rainfall. He says: "Wherever moisture is equable and abundant, we have the densely clothed forest; wherever it is unequally distributed, we have the grassy plain; and wherever it is mostly withheld, we have the inhospitable desert."[2] This is unquestionably the law, but the Weather Bureau observations of the past twenty years establish the fact that the prairies can in no wise be due to insufficient moisture. Clearly Foster failed to differentiate prairies and plains.

2. The beliefs that the prairies were treeless because of accumulations of peat, and that the soil was too acid, have long been disproved by the farmers who have worked them.

3. J. W. Redway's theory that the prairies occupy an ancient inland sea and never were forested, must give way before the fact that they were crossed in every direction by

[2] *The Mississippi Valley*, by J. W. Foster, 1869, p. 71.

belts of trees following the water courses, and were interrupted by frequent groves or "oak-openings."[3]

4. The suggestion that there is no forest on the prairies because the trees were driven out during the last glacial period, can not be considered seriously for the same reason as the foregoing, and because there are, and have been for ages, forests far to the north of them and on all sides except the west.

5. The claim that the close prairie sod is a barrier to the establishment of tree growth is partly true only. Sod may discourage for a time the germination of tree seeds; but there is abundant evidence that where other conditions are favorable, the trees will ultimately prevail.

6. That buffalo and other grazing animals may have produced some of the smaller prairies about watering places or salt licks is quite possible, but that such a force could have controlled three thousand miles of forest front is not probable. Moreover, the herds had greatly decreased some time before the forest began to gain on the prairie.

7. The theory that has had most general currency is that of Professor Whitney,[4] who pointed out that forests as a rule occupy gravelly or open soils and avoid the fine, deep sediments, and from that argued that the prairies were treeless because their soil was too fine and close to properly nourish the roots. That the soil of the open prairie is often close and heavy is true, but the relation between soil and forest is not constant enough to support the theory. In other words, if fine soil will not support tree growth, trees must never be found naturally on fine soil; this, of course, within reasonable limits. As a matter of fact, the soils within the prairie area are quite varied, and any of them may be treeless, or they may carry forest. In "The Soils of

[3] Jacques W. Redway, in *The Geographical Journal* (Eng.), III, 1894, p. 209.

[4] *Plain, Prairie and Forest*, by J. D. Whitney, 1876, p. 8.

Illinois" it is said: "The surface of this white clay district is nearly equally divided between forest and prairie. The former borders the streams, and the latter occupies the divides."[5] The white clay is the finest in the author's classification, and "is so compact that much of the water stands on the surface until removed by evaporation."

The recent investigations of the U. S. Bureau of Soils are apparently conclusive upon this point. Of the Yazoo clay found in St. Clair County, Ill., it is said that "when wet, three or four inches of the surrounding soil will stick to the auger when it is withdrawn from a boring," and that "this type was originally heavily timbered, with some small prairies scattered through the timber."[6]

Again, in the report of the Survey of the Dubuque, Iowa area it is said: "The more broken lands along the Mississippi River, together with fringes along the streams, were occupied by forests of white, black, and bur oaks, basswood, hickory, elm, and poplar. In the area above or west of the Niagara escarpment, comprising the rolling prairie, there was no timber except here and there an occasional tree, and a narrow fringe along the streams. Here grew coarse prairie grasses. . . . There is apparently no difference in the soil sufficient to account for such a difference in vegetation."[7]

Evidence of this kind is abundant, and when considered in connection with the observation frequently made that the forest is gaining on the prairie in many places since the country has been settled, it is quite evident that the fine-soil theory is untenable.

If we locate on a map what are now recognized as prairies, it is seen that the most important, the great prairie, lies west of a line that follows in a general way the 95th

[5] *The Soils of Illinois*, by Frank Leverett, 1895, p. 91.
[6] Field Operations, Bureau of Soils, 1902, pp. 519 and 521.
[7] Field Operations, Bureau of Soils, 1902, p. 572.

meridian, except where it makes a great bend eastward and encloses half of Iowa, more than half of Illinois, and portions of Wisconsin and Indiana, and where it parallels the Gulf of Mexico. (See Fig. 2). No map can show the actual irregularities that mark this border between forest and prairie, for nowhere is there a sharply defined line. The prairie thrusts itself into the forest in long tongues or broad lobes, and the forest is projected westward in everlessening density. Often bodies of timber are entirely surrounded by prairie, like islands in a sea, or a small prairie will be entirely surrounded by timber. A notable instance of the former is seen about Dubuque, Iowa. On the west the prairie has no definable border, but is gradually merged into the plains, which in turn stretch westward to the base of the Rockies.

If we picture for a moment this united area as it must have been before man came on the scene, but after the physiographic features were adjusted approximately to their present relations, the great Eastern Forest will be found stretching westward until its front begins to be broken near the 97th meridian by climatic conditions that are less favorable to tree growth; thence westward through a few more degrees of longitude the more hardy trees straggle, until finally all disappear except the cottonwoods, willows, and ashes which fringe the rivers. The rivers are deeply cut in the plain, and the latter is clothed with grasses, the support of great herds of buffalo, deer, and elk. Then come the Indians; they find that the tall grasses impede them in their hunting, that they shelter their enemies; a fire is set and goes roaring eastward. After that the ground is clear until next spring, when it is discovered that the new growth of grass is finer and fresher than that which comes on the unburned places, and the game is attracted to it. Much better hunting than before. No one knows or cares what became of the fire that rushed east-

FIG. 2. THE PRAIRIE REGION OF THE UNITED STATES WITH LINES OF EQUAL RAINFALL

ward; maybe it died at a river, maybe it kept on until it reached green timber. In the latter case the common modern remark would apply, "No harm was done, for only a few young trees were killed; the old ones came through all right." Next year other fires came the same way, and ate a little further into the forest; or, if they missed a year or two, they burned so much more fiercely. After awhile the ground that was once close, heavy forest became more open, the trees were all old and stood apart from each other, and between them was fine sod.

Still the fires kept on; every autumn when the grass was dry, it got afire and burned eastward further and further into the forest. Back on the edge of the plains, where the early fires first came, the old trees were beginning to die; they fell one by one, and the fires consumed them. They left no trace and no descendants. The prairie was there.

This picture is pure imagination, but is it not probable? We know that throughout all this region the prairie fires were a constant menace to the property, and even to the lives of the early settlers; that for a time they were accepted as an inevitable accompaniment of the dry seasons; but that as population increased and property accumulated it was found possible to check, and finally to stop them altogether. We know that in every section of the country recurring fires have extinguished the forest over considerable areas, and they are doing it now in just this way. In southern New Jersey, in the South, in the Lake States, one can see the process going on. It matters not that in some cases the lumbermen have preceded the fires; the course is essentially the same.

Opponents of the fire theory contend that fire leaves traces; that charcoal is almost imperishable, and would have been discovered had the forests been burned. They do not appreciate how completely one fire after another

consumes everything burnable, that the charred trunks of one season become ashes in the next; nor do they allow the time element. The making of a prairie is not a catastrophe in the sense that the face of nature is changed at a stroke. It may be that a hundred years were required to convert even an acre of forest to prairie.

There are two things about the line separating forest from prairie that are striking; first, that it is very much like the wavy line left by a fire that has run through grass or timber under the impulse of a strong wind; and second, that the cuts or lobes generally extend in an easterly direction. This is especially marked in the great lobe that covers the northern half of Illinois, southern Wisconsin, and a part of Indiana, Minnesota, and Iowa.

On the ground or in written descriptions one learns that westward of the border proper are, or were, islands and peninsulas of timber, some of them dense, as the forests of a humid climate always are when undisturbed, others composed of veterans only, trees standing wide apart, yet often having the long, straight stem that characterizes those grown in close association; the last are the "oak-openings."

The observation of these conditions suggests a gradual extension of the prairie eastward from a point where climatic conditions alone limit the growth of trees. What would cause such a movement? One remembers that the prevailing winds of this latitude are westerly, yet they are neither constant enough nor strong enough to hold back the line of trees. At this point a series of reports of forest and prairie fires collected some years ago was of service. From these it was learned that in this section fires were most frequent in the fall, although in one or two months of the spring also they were common. Out of 590 fires reported from the ten States of Illinois, Iowa, Minnesota, North Dakota, South Dakota, Nebraska, Kansas, Indian Territory, Oklahoma, Texas, — all containing more or less

prairie, no less than 50 per cent occurred in the months of September and October. In some States the percentage for the two months was as high as 75. Of the 179 fires reported from the four States lying immediately west of these, Montana, Wyoming, Colorado, New Mexico, 30 per cent occurred in September and October. The dry season is longer there. These facts point strongly to a relation between the fires and the condition of the vegetation. Is there also a relation to the winds? It is of course impossible to know what were the exact climatic conditions in times past, but meteorologists affirm that there is no reason to believe that the climate of the continent has altered within a period that would suffice to bring about the change that is suggested. Moreover, prairie fires or forest fires do not gain their destructive force under normal, average conditions so much as through those which are exceptional. Farming may be profitably followed in a region subject to fires, if the latter *usually* come after the crops are harvested. And the same is true of drouths; if a crop is lost one year, the next may be gathered. But drouths or fires coming no oftener than every five years, or even less frequently, could effectually extinguish a forest.

The records of the Weather Bureau seem to furnish all the evidence that is now required. The western limit of the region having an annual rainfall of at least 20 inches — the minimum generally thought necessary for some sort of tree growth, is far to the west of the prairie line. But the precipitation of the growing season is much more important, for trees as for crops, than that of the whole year. Another line from the Weather Bureau charts shows the limit within which 15 inches fall from April to September. Except in southern Texas, it is west of the 20-inch annual. Somewhere near this line should be the western border of the Eastern Forest. But there is another line that is of interest. It represents the extreme eastern position of a

seasonal minimum of 10 inches. North and south, the forest is west of it. Just where the prairie swings farthest east, this line bends west. Clearly such deficiencies in precipitation are not frequent enough to appreciably influence the tree growth.

The significance of these comparisons is that they show the western border of the prairie to be indeterminate, on debatable ground, while the eastern lies mainly within the limit of even occasional rainfall deficiency. In one place it is no less than the width of two States, or about 500 miles.

Accepting the record of seasonal fires just referred to as indicative of the time of year when such an agency would have been most effective in pushing the prairie eastward, it must be shown that protracted drouths and strong westerly winds are prevalent at a time when vegetation itself is dry and easily ignited. This it is possible to do from the detailed weather reports. The following summary is made from the September and October record for the years 1899 to 1903, at five stations between the Rocky Mountains and the 15-inch April-to-September isohyet, seven stations between the latter and the forest boundary, and four stations within the great lobe. (See Fig. 2).

Beginning at the north end of the first group, Havre, Montana had an average monthly precipitation of but .76 inch, with but two months out of the ten when two inches or more fell, and six monthly totals of less than half an inch. With one exception, the prevailing winds were westerly, and the monthly maxima, ranging from 35 to 54 miles an hour, were all from the same direction.

Miles City, Montana had even less precipitation, — .71 inch average, and four months with not more than one-tenth inch. The prevailing winds were westerly, and the monthly maxima, with two exceptions, were from the same direction. Velocities of 30 to 48 miles were recorded.

Cheyenne, Wyoming had two heavy storms in 1900 and 1902, yet the monthly average was but 1.04 inches, and five months received less than half an inch each. With two exceptions, the prevailing winds were westerlies, as were all the maxima — 30 to 48 miles an hour.

Pueblo, Colorado recorded the least rainfall of all, 0.47 inch. In no month did so much as an inch fall. During six months out of the ten, westerly winds prevailed, but the maxima — 29 to 50 miles per hour — were divided between westerlies and northerlies.

Amarillo, Texas comes within the influence of the Gulf winds and the moisture that they carry; yet even there, with prevailing southerlies and an average monthly precipitation of 2.56 inches, five months out of the ten recorded totals below the 2 inches that is commonly held to mark a drouth. Of the high winds, four maxima, with velocities of 34 to 60 miles, were westerlies.

Turning to the next group, stations between the 15-inch seasonal isohyet and the border of the Eastern Forest, Bismark, North Dakota had an average monthly precipitation of but 1.39 inches, and three months with less than half an inch. With one exception, the prevailing winds were westerly, and of the maxima, 29 to 60 miles per hour, all but three were from the same direction.

Pierre, South Dakota averaged but 1.18 inches monthly rainfall, and three months had less than half an inch. The prevailing winds were southerly, yet all but two of the maxima — 37 to 52 miles per hour — came from the west.

North Platte, Nebraska had an average monthly rainfall of but 1.06 inches, with six months in which less that half an inch fell. The prevailing winds were westerly, and of the maxima — 24 to 40 miles — all but three were the same.

Concordia, Kansas lies well to the east of the 20-inch annual isohyet, and consequently shows a monthly average of 2.87 inches; yet of the ten months, three had less than

two inches. The prevailing winds were all southerly, yet three maxima were from the northwest. It is of interest to note that this station is near one of the most westerly extensions of the forest.

Dodge, Kansas had an average monthly precipitation of 1.98 inches, yet three months received less than an inch each, and in September, 1903, but 0.15 inch fell. The prevailing winds were southerly, and only two of the maxima came from the west. Both, however, were in the months of least rainfall, and had velocities of 42 and 48 miles an hour.

Oklahoma, Oklahoma like Amarillo, Texas, is within the influence of the Gulf winds. It had an average rainfall of 2.76 inches, yet in five cases the monthly totals fell below two inches, and in one month but 0.67 inch fell. The winds were prevailingly southerly, but four of the maxima — 32 to 48 miles per hour — came from the north and west.

San Antonio, Texas though so near the Mexican Gulf, had an average of but 2.27 inches rainfall, and five months with less than two inches each. Southerly winds prevailed, yet in three cases maxima came from the northwest, and two more from the north.

Of the stations belonging to the third group — those within the great lobe, and consequently with more than 20 inches of rain during the crop season — Sioux City, Iowa had a monthly average of 3.11 inches and prevailing southerly winds, but six of the strongest winds came from the northwest. Two of these, with velocities of 38 and 46 miles an hour, occurred in months having but 0.63 and 0.26 inch precipitation.

Des Moines, Iowa had an average monthly precipitation of 2.49 inches, yet in four cases it fell below 2 inches, and in October, 1899, to 0.59 inch. Westerly winds prevailed, and in every case but one, the maxima — 31 to 42 miles per hour — were from the southwest.

La Cross, Wisconsin had an average rainfall for the ten months of 4.06 inches, with extremes of 1.06 inches and 12.09 inches. The prevailing winds were southerly, yet in every case but one, the strongest winds — 25 to 36 miles per hour — came from the west or northwest.

Springfield, Illinois has 38 inches of rainfall per year, yet the ten months of record show an average of but 2.73 inches, and three months with less than 2 inches. The prevailing winds were southerly, yet here again half of the strong winds came from the west, and in two cases they occurred in the months of least precipitation.

These details establish beyond question the fact that the rainfall of this region is either deficient or very erratic, and alternates with periods of drouth, and that whether the prevailing winds be westerly or from another quarter, high winds are very apt to come from that direction. This is especially marked in that part of the area north of the Kansas-Nebraska line, and probably explains why the Iowa-Illinois-Wisconsin lobe extends so much farther eastward than the rest. South of Nebraska the Gulf influences come in, carry the isohyets westward, and undoubtedly account for the extension of the forest in the same direction.

The question of relative humidity has not been considered because data relating especially to the periods of drouth and high wind are not available. This, however, is not necessary, nor is it worth while to follow the record for more than five years and for the two fall months. A fuller study would doubtless alter the figures somewhat, but it would throw no more light on a situation that meteorologists have long recognized, and with which the people of the region are thoroughly familiar. Furthermore, we can prove nothing of what did transpire in time long past. The argument must rest upon such inference as is reasonable from recent observation.

To the question whether the great prairie had reached

its limit, assuming that the forest was destroyed by fires, I am inclined to answer that it probably had. The records of the southern stations show the strong influence of the Gulf winds, which would tend to drive the fire back towards the plains, and at the same time scatter seeds from the forest. Further north, while the westerly winds prevail, the precipitation becomes more plentiful and is more equally distributed throughout the year. Eastward of the Mississippi, drouths while by no means unknown, are less severe and less protracted than they are further west.

With reference to the smaller areas called prairies, I do not think we need have much trouble. Those found in Kentucky, Tennessee, Arkansas, as well as countless others of less size in Illinois, Indiana, Missouri, Mississippi, and other States, are either recognized burnings that are rapidly closing up wherever the fires are stopped and the land not used, or they are beaver meadows, filled lakes, or drained water ways. From all of these the forest is but temporarily excluded by the peat and grasses. We probably can not know how each of the larger areas became a prairie, yet it is entirely reasonable to assume that some of them may have had a salt lick or lake meadow as a nucleus, from which they were gradually extended by annual fires set by Indians in pursuit of the game that congregated there. The "big lick" to which Boone and the "Long Hunters" from North Carolina were attracted was a part of the extensive prairie in which Nashville, Tennessee, now is; while Kentucky and Tennessee, with many such openings in the great forest, were long the hunting and battle ground of the northern and southern tribes. Fires on these prairies are mentioned by almost every early traveler, and not a few confess to having started them.

The savannahs of the southeastern coast, and of many semi-tropical regions, are simply another group of prairies. Some of them, in whole or in part, are apparently

treeless because they are periodically overflowed by brackish water; but there is no doubt that fire, originated by hunters or cattlemen, has played a part in extending them.[8]

In the making of none of these isolated prairies can constant winds be assumed to play a part. The fires doubtless burned in any and every direction.

Two considerable so-called prairie areas remain to be considered, and I confess to being still in doubt about them. The first is that part of the great prairie lying along the Texas and Louisiana coast, or rather some miles back from the coast. It is true prairie because there is no deficiency of moisture and because the relatively few trees on it are being rapidly reinforced by a natural extension of the forest that lies to the north of it.[9] The soil is rich and sweet, and much of it is now being farmed. I am inclined to believe that here southerly winds played the part of the plains westerlies, and drove fire from the salt marshes which fringe the coast back into the timber.

The other area is the central valley of California. Though called a prairie, it is evidently a true plain, in its central portion at least, and treeless through drouth. It is entirely possible that the borders have been extended by fires, which are, or were, common enough. The valley winds, blowing up and down, and the mountains that rim it, would both aid such a process.

The argument for the fire origin of the great prairie may be summed up thus:

The area is situated where forest ought to be, for there is neither lack of rain nor any condition in the soil or the vegetation that will account for the absence of trees. It must therefore be assumed that something not entirely normal caused the forest to retreat from its proper position.

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[8] *Lehrbuch der Oekologischen Pflanzengeographie*, E. Warming, 1902, p. 274 ff.

[9] *Forest Resources of Texas*, W. L. Bray, p. 19; Bulletin 47 Bureau of Forestry, 1904.

With the knowledge of the habits of trees that we now possess, it is evident that fire is the only agency that could produce such a result, but to be effective, it must be repeated or long-continued. The situation answers this requirement. To windward of the area now prairie, but which at one time must have been forested, lies a great plain clothed with grasses. This region, normally deficient in precipitation, is subject to protracted drouths, which frequently extend over the adjacent woodland, and cause all forms of vegetation to become dry and combustible. At the same time that these drouths occur, strong winds are apt to blow from the grass land towards the forest. These gather force as they progress, for the country is flat or gently rolling, and little opposition is offered to them. Thus every condition is favorable to the rapid eastward spread of any fire that might be started in the dry grass. That fires were started, and that they were of almost annual occurrence, are matters of history.

The observation of these facts does not prove that the fire drove the forest back and made the prairie; but when it is clearly shown that since the settlement of the country, the forest has gained on the prairie in every direction, it must be admitted that the deterrent influence is no longer active, and that as the only change that the settlers have made in the earlier conditions is to stop the fires, the fires must have been that influence. This reclamation of the prairie is by no means local or limited. Wherever tree seeds can reach uncultivated land, there the forest is extending. In Illinois, Iowa, and adjacent States, this effect is noticed chiefly along the water courses, for there only were seed trees; yet all over the southwest mesquite is rapidly spreading from seed distributed by the range cattle. There can be little doubt that the seeds were formerly distributed quite as widely; the plants were simply kept down by the fires. Contrast the Plains of the Rio Grande in Texas,

open country forty years ago, but now forested,[10] with the Plains of southern New Jersey, where a forest has been replaced by practical nudity within quite as short a time through the sole agency of fire. The name plains is used in both sections because one area was, the other is treeless, or nearly so. Neither lacks rainfall.

How does this interpretation of the origin of the North American prairies apply to those other areas which, under the names of steppes, llanos, campos, pampas, etc., present similar conditions? Unfortunately, exact information concerning any of them is lacking, and I have had opportunity for only a brief observation of the Hungarian and the Russian districts; yet a reference to them is worth while, if only that some local student may consider the question from this new point of view.

The district that represents the chief prairie problem of Europe is the "Black Earth" of southern Russia. The soil is fine, dark, and fertile, and trees are few or wanting. A German authority says that "this area, the North American prairies, and the pampas of South America all belong to the same formation, and that everywhere where fine-grained soil is, are steppes, and everywhere where sandy or open soil is, are forests. The distinction between grassland and forest is always traceable to the soil." He further says, "The North American prairies are the same in character as those of eastern Europe; the same conditions are due to the same causes."[11] The fore part of Professor Ramann's statement is but an acceptance of Professor Whitney's theory; with the last I quite agree.

By referring to official maps it is seen that the great Russian prairie lies between a forest and a plain, just as that

[10] Bulletin 47, Bureau of Forestry, U. S. Department of Agriculture, 1904, p. 33.

[11] E. Ramann: *Forstliche Bodenkunde & Standortslehre*, 1893, p. 252 ff.

of North America does, except that the lines of separation run east and west instead of north and south. The 20-inch annual isohyet (there is none published for the growing season) is very irregular; yet it includes much of the Black Soil, and excludes all of the treeless belt lying between the 45th and 50th parallels. The line marks a transition, as does the corresponding one in the United States; south of it the forests are open, and chiefly of hardwoods, until they give way entirely to the steppes. On this border, as on the corresponding one in Kansas, Nebraska, and the Dakotas, great grain crops are raised by favor of the early summer rains. The drouths that follow in both regions effectually prohibit the natural growth of trees.

The isohyets in the Caucasus are likewise interesting. From Batoun, where the annual average rainfall is 80 inches, the precipitation falls off rapidly northward, until the 20-inch line is reached a little south of Rostov and north of Stavropol. Thus southern Russia — the steppes, clearly is treeless because not enough rain falls. Tracing now the seasonal climate of the steppes and prairies, it appears that the rainy season is in June, after which the average monthly precipitation falls rapidly, and through most of the fall and winter is considerably less than 2 inches. East of the Volga to the base of the Urals more than 1 inch of rain per month is rare, except in June.

With respect to the winds, westerlies prevail in Europe as in North America, yet on the steppes there is a marked influence towards the north. After the rainy season (June) they are variable for awhile, but by September southwesterlies are frequent, and by October they are dominant and last through November. From the Caucasus, southeasterlies, which must be dried in passing the summit, appear, but available reports are not conclusive.

These facts can be accepted as suggestive only, though they point to a close similarity between the conditions in

Russia and in the United States, and consequently to a probability that Cossack fires did in one case what Indian fires did in the other. I do not know to what extent, if at all, the forest is now gaining ground on the Black Soil, yet the Russian Government is successfully planting trees in several parts of the district, notably in the province of Voronege.

One other prairie district deserves a brief notice — that of South America. I have been unable to locate accurately the area that may be accepted as prairie, for there is a confusion of names as in the United States. One observer says that "the pampas of Brazil and Argentine are sometimes without rain for a year;" [12] another that "the pampas of Argentine, originally forestless like our prairies, now grow poplar, willow, eucalyptus, and fruit trees planted by the farmers." [13] P. V. Lund [14] believes that the campos of Brazil are made from the forest by fire, and Warming himself says [15] that trees on the margins show marks of fire.

The inevitable conclusion from these statements is that there is a region of plains and a region of prairie. Fortunately, Argentine has a good weather service, and its reports confirm this view. Using again the 20-inch annual isohyet as marking the boundary between what may be forest and what can not, we find that the line runs almost parallel with the Andes Mountains, and about 10 degrees west of Buenos Ayres, which has an annual rainfall of 30 to 40 inches. The precipitation is least from June to August, their winter; but in the season, March to May, corresponding with our September, October, November, a belt of considerable width east of the Andes receives but 2.4 inches,

[12] Warming *loc. cit.*, p. 272.
[13] F. W. Bicknell, in unpublished MS.
[14] Quoted in Warming, p. 371.
[15] Warming, p. 279.

or 0.8 inch per month, while close to the mountains is a strip that gets almost none. This situation exactly parallels that found in the United States between the eastern base of the Rockies and the Mississippi River, but the similarity of the winds of the two regions is not so marked. The lower part of South America is a mere ridge of land between two oceans, and sea winds from both sides are common. Westerlies prevail during the winter, but easterlies are dominant in summer and fall. Nevertheless, it must be admitted that the westerlies, though only occasional, are more potent in affecting vegetation, for they descend from the high mountains completely exhausted of their moisture.

I am not prepared to say that the portions of the pampas having normally sufficient rainfall for tree growth have been won from the forest by fire. It may be that occasional drouths, salinity in the soil, or something else is responsible; yet I have not much doubt that the course of events has been the same as in the United States. Herds of wild cattle still inhabit the grass country, and fires are of annual occurrence. Some of them must burn eastward and attack the forest. Fire is the ally of the prairie, the bitter enemy of the forest.

PRINCIPLES INVOLVED IN DETERMINING FOREST TYPES

RAPHAEL ZON

Delivered before the Society February 23, 1905

A problem most peculiar to our forest conditions, and promising, if properly solved, most productive results, is the problem of forest types. Whoever has studied forest conditions has had to recognize forest types; but few of us have approached the subject in such a broad and truly scientific manner as did Professor Graves in his "Practical Forestry in the Adirondacks."[1] Forest types, as I shall attempt to show, are the corner stone of silvics, and there can be no real progress in our silvical studies until the question of forest types is settled. I can hope to contribute only a few suggestions to this all-important problem.

A forest is not a mere aggregation of trees, just as a human society is not a mere aggregation of human beings; it is a complex body — a tree society, governed by laws distinct from those governing individual trees. Since silvics has for its object the study of the laws of this tree society, its position among natural sciences can, therefore, be justly compared to the position of sociology among humanitarian sciences. In 1891 a book entitled "Ecological Geography of Plants," by a Dane, Professor Warming, outlined for the first time the principles of a new field of botanical investigation which has since become known as ecology. The subject of the new botanical discipline is not individual plant forms, but plant groups or plant societies. It describes the existing plant societies, as far as they can be divided into distinct groups with well-defined features, and

[1] Bulletin 26, Division of Forestry, U. S. Department of Agriculture, 1899.

endeavors to find the reasons that caused them to group together and the factors that made them assume their characteristic features; in other words, just what silviculturists have been trying to learn for over a century regarding tree societies — forests. Silvics, dealing with tree societies alone is, properly speaking, only a branch of the much broader discipline — ecology, which deals with plant societies in general. In the past, under the pressure of their practical needs, the foresters were the only ones who tried to learn the peculiarities of trees as social beings; now their efforts coincide with those of many other investigators of plant life, and promise, therefore, to become of a more general scientific character.

Tree societies, or forests, just like human societies, present a great variety of forms. As soon as you enter a forest, you readily find that it is seldom uniform over a large area. Even the pure longleaf pine forest, typical for its tiresome monotony, proves upon closer examination not entirely uniform. A little attention and you will discover stands differing from each other in density, age of the trees, or character of growth; and you soon come to realize how difficult it is to find even in such a uniform forest two areas similar in every respect. Now the first step in any silvical study or attempt at forest management is to reduce the great variety of stands to a small number of types, each having characteristic features of its own and requiring a distinct treatment. The nearer we come to establishing natural types of forest growth, the deeper we penetrate into the true relationship existing between these types and the factors that produce them, and this is the most important contribution to silvics.

The division of a forest into natural types of growth, however, is not such a simple thing as it may appear at the first glance. Stands differ from each other in many respects; they may be pure or mixed, even-aged or irregular,

dense or open, of seedling or sprout origin, etc. Which of these features justify the subdivision of the forest into types of growth? and what must we call a natural forest type? In order to answer these questions, we must analyze the factors that produce the great variety of conditions of forest growth and determine which of these factors are fundamental and permanent and which are only secondary and temporary. When we attempt to trace to some definite causes the differences between stands composing a large forest we finally come to two main ones: first, external physical conditions, such as climate, soil, moisture in the ground, topography, exposure, etc.; and second, interference by man, and natural accidents, such as fire, wind, and so on. Interference by man and natural accidents to the forest are principally responsible for the secondary, less-important differences in stands, like density, mode of origin (sprouts or seedlings), age, though they frequently lead to even a temporary change in the composition of the forest. It does not take very long to realize that segregating stands into types based on density, age, or mode of origin can not be justified, since such features are not permanent and can not be characteristic of any definite forest type. Stands may differ radically from one another in character of growth and nevertheless have the same density or the same age, and *vice versa*; stands of different ages and density may at the same time exhibit the same character of growth. This is so evident that none of us has ever attempted to base the making of forest types on the age, density, or mode of origin of the stands. Another thing is the composition of the stands. As a matter of fact, most of our forest types are based on the prevalence of one or another species in the composition. Is composition a safe guide in establishing forest types? We know, for instance, that after white pine or spruce forests are cut over and burned by fire, aspen, birch, cherry, and other hardwoods take

their place. This occupation of the ground, however, is only temporary; eventually white pine and spruce reappear beneath the hardwoods and crowd them out, thus restoring the original type of growth. Such examples are very numerous. Throughout the Catskills the original forest contained hemlock in large quantities, as can be learned from the history of the past lumbering in that section and the large hemlock trunks and rotten stumps still in great evidence throughout the forest. Now the main growth is mostly hardwoods of poor development, beneath which a most luxuriant and persistent young growth of hemlock can often be noticed coming up. Many slopes in the White Mountains, where fine spruce forests grew originally, are now covered with northern hardwoods. Shall we class the aspen and white birch coming up after white pine, or the hardwoods coming up after hemlock and spruce, as natural forest types, when we know that they are only transitory in character, and that eventually, if nature is left to herself, the original mother type will be restored on those situations, because the physical conditions favor it? A forester who mistakes such temporary forest growth for the original natural types, thus failing to understand the natural evolution of the forest, will always have nature against him in all his operations, instead of being aided by her. He will open up the forest with the intention of getting reproduction of the standing hardwoods, and to his surprise he may find spruce or hemlock instead. His tables of future yield, prepared on the basis of the present composition, will be an especial disappointment to him, because with each new cutting the percentage of the temporary species will steadily decrease, being crowded out by the incoming original species much better suited to the situation, which were not taken into consideration at the time the tables of future yield were prepared.

But leaving out such temporary changes in the composi-

tion of the forest which are traceable to the influence of man or fires, the prevalence of one or another species in the composition can not be relied upon for making natural forest types even in a virgin forest untouched by man. Who, for instance, would even for a moment, throw together in one type Adirondack spruce growing in the swamps, with spruce on the slopes though its percentage in both situations may be identically the same? The growth of the individual trees, and the development of the whole stand in the two situations, is as radically different as if we had two entirely different species. The influence of man, wind, or fire may bring about a change in the density and other secondary features, and in extreme cases, even a temporary change in the composition of the forest; but if the fundamental physical conditions of growth remain unchanged thereby, the forest will in time return to its original type, conditioned by the external physical factors, just as a stretched string set to vibrating by a stroke of the finger returns sooner or later to its original position, determined by the points at which its ends are fixed. The changes which are brought about in a forest by the interference of man or by accidents can not, therefore, serve as a basis for the establishment of fundamental forest types. However, since these changes must be reckoned with, often being of such a character as to necessitate a special silvicultural treatment, we may call them temporary, transitory, or derivative types, in distinction from the fundamental forest types, which are the result of natural factors only.

The physical conditions of the situation then are the main factors which determine the whole character of a forest type. Of these physical factors, climate has undoubtedly a marked influence upon plant life, if we compare vegetation of different latitudes. Within the same climatic zone, however, many plants, and especially forest trees, are but little sensitive to small variations in climate, and, all

other conditions being equal, develop normally within the boundaries of the larger ranges of their horizontal geographical distribution. It is evident, therefore, that in even a large forest, covering a level or only hilly country, the difference in character of growth can not be ascribed to the direct influence of climate. Soil, moisture in the ground, and topography, to which in mountain countries must be added altitude and exposure, are the main factors which determine the character of forest growth in a forest region, and, therefore, must be accepted as the basis for the division of the forest into natural types of growth. A natural forest type then is an aggregation of stands which may differ from each other in age, density, and other secondary features, but have the same physical conditions of situation, soil, topography, exposure, etc. In a virgin forest the least variation in the physical conditions of a situation is followed by a change in the character of the forest growth, which is a mere function or expression of those physical conditions. The relationship between the physical conditions of the situation and the character of growth upon it is so constant and characteristic that by the given physical conditions of a situation, like soil, topography, and so on, one can describe the general character of its forest, the predominant species, habit of trees, reproduction, undergrowth, and *vice versa*, by a given type of forest, one can describe the physical conditions of growth, soil, situation, etc.

If the subdivision of a forest into types of growth must be based not so much on the features of the stands as on the similarity in the external physical conditions of their situation, the first step in establishing forest types in any region is to divide the forest area according to its salient topographical features, like river bottoms, slopes, and ridges, and then to further subdivide it within a uniform topography according to soil, moisture in the ground, exposure, etc.

In this classification the differences in the character of forest growth must always be considered, since only by going back and forth from the physical conditions of situation to the character of forest growth can the relationship between the two be determined. But it must not be forgotten that the forest growth may sometimes be only temporary, and, therefore, does not represent the kind of forest which, being particularly suited to the situation, would normally grow upon it. The importance of being able to distinguish between a temporary and a fundamental type has already been pointed out; the means for distinguishing them are to be found in the physical conditions. If we discover stands widely differing from each other in composition, though the physical conditions of their growth are seemingly the same, we may reasonably suspect that not all of them are the original forest growth. By learning the past history of each particular stand, or by comparing it with unquestionably virgin stands under similar physical conditions, there should be no difficulty in deciding which is the original forest type and which is the temporary one, provided we did not overlook some actual differences in the physical conditions of their situation.

Having accepted physical conditions of situation as the basis for dividing a forest into types, we must still find some criterion to guide us in deciding what differences in the physical conditions justify the establishment of two different types. Such a criterion is given in the reproduction of the forest. Only such differences in the physical conditions as are followed by differences in reproduction justify the segregation of stands into separate types. Of all the vital functions of the forest, reproduction is the one in which the forester is most interested; the manner in which the forest reproduces itself, or can be reproduced, is dictated by the very nature of the forest. We would undoubtedly fail utterly if we attempted, for instance, to

force reproduction under the shelter of mother trees upon the longleaf pine forest, since the young longleaf pine seedlings demand direct sunlight for their development. One may travel miles and miles through the mature longleaf pine forests of Texas without finding a single young, thrifty tree under the shade of the old longleaf pines, and come upon many of them in every opening. In the loblolly pine forest that has succeeded in establishing itself on the dry uplands, the young seedlings that appear in abundance almost every year in the fall and early spring all die during the summer from lack of moisture in the ground, while in the loblolly pine forest on the lower situations, where the water level is near the surface, there is always a good reproduction. It stands to reason that the same method of reproduction can not be applied to both situations. The fact that loblolly pine on the dry uplands is capable of establishing itself on old fields, the soil of which has been made more retentive of moisture by cultivation, hints at the only method by which loblolly pine on such situations can be reproduced with reasonable certainty. I could bring many instances of this kind to show how differences in the physical conditions of growth affect the method of natural reproduction of the forest. To secure reproduction of the forest is the most important silvicultural operation of the forester, and since forest types are silvicultural units, requiring distinct silvicultural treatment, the difference in the method of reproduction caused by a variation in the physical conditions is the most natural criterion for differentiating a forest into types. Moreover, every change in the physical conditions that will necessitate another method of reproduction will at the same time affect the growth of the trees and all other features of the stand.

A forest type is the result of a long struggle for existence between different species, in which only those possessing the greatest vitality and a fitness for the physical conditions

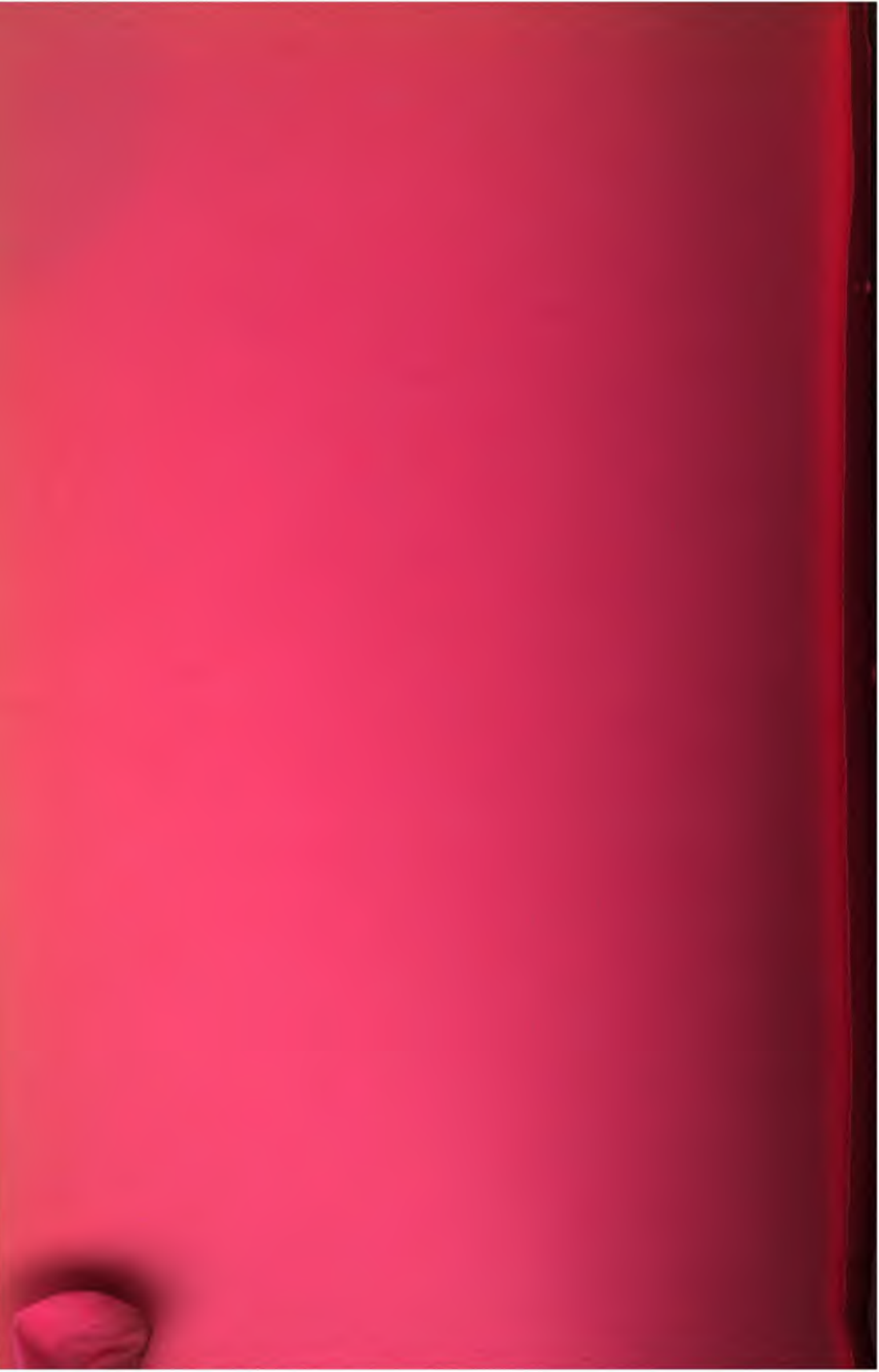
of situation succeed, in occupying the ground and forming tree associations having a distinct physiognomy. One of the most important characteristics of a forest type is its stability, its resistance to invasion by other plant forms. The closer the composition of the forest is in accord with the physical conditions of the situation, the more resistant it is to dangers of all kinds, insects, snow, etc., the easier is its treatment, the greater results can be obtained from the application of one or another method of thinning, and the more certain is its reproduction. European foresters were at one time carried away with the idea of a pure forest, and later with the idea of a mixed forest, as a panacea for all dangers to the forest and a guarantee of the success of all cultural operations. We now know that only a forest growth which is perfectly suited to the physical conditions of the situation proves resistant to all natural dangers that may threaten it, no matter whether it is pure or mixed. A forest type possessing the most valuable quality — stability — is, therefore, the ideal to which a forester must strive in regenerating and caring for his forest. In reproducing the cut-over forest, the forester must endeavor to obtain in the shortest possible time the original forest type; and since in the majority of our forests, as a result of cuttings made without regard to the silvical requirements of the species, the original type is mostly supplanted by a temporary growth, the principal aim in caring for cut-over areas is to restore the original forest type. After having established the relationship between a forest type and the physical conditions of situation, and having the picture of the forest type clearly in our mind, we can bring back the original growth in places which have been deprived of forests for many years; in other words, we may have within a forest region types of situation which, if they were under timber, would bear a definite type of forest growth. Such types of situation become exceedingly helpful in reforesting waste

or cut-over land. Knowing the type of forest growth which can be best supported by each type of situation within the forest region, there can be but little difficulty in deciding what species to plant on each type of situation.

The study of the habits of our forest trees must be confined to definite forest types; we have no right to speak about the silvical feaures of spruce, white oak, or any other species in general, but only as members of definite forest types. The silvical features of spruce, white oak, or any other species in one forest type differ essentially from the same in another type. Often the difference between the individual trees of the same species growing in different forest types is actually greater than between two distinct species, as for instance in the case of spruce growing on the slopes and in the swamps of the Northern Forest. Loblolly and longleaf pines growing on old fields have more in common as regards their life history, character, and rapidity of growth, light requirements, reproductive maturity, etc., than loblolly pine on old fields and loblolly pine on the poorly-drained soils of the lowlands.

The deficiency, and often even the contradictory character, of a great many of our silvical facts is due mainly to this disregard for the true forest types in which the observations were made, and the arbitrary character of the subdivisions which were called forest types. The study of the life habits of our forest trees, and the establishment of forest types must, therefore, go on hand in hand. Yield and volume tables should be made separately for each forest type. Forest types should be laid in the foundation of all experimental forestry work; experiments with the application of one or another method of thinnings, for instance, must be made in the same forest type if the results are to be compared and true deductions made. In order to place our silviculture on a safe basis, each forest region should be divided into permanent natural forest types, or types of sit-

uation with forest growth corresponding to them, just as many sections of the country are already classified according to soil types mapped by the Bureau of Soils. These forest types, or types of situation, would then become the basis of all our practical forestry work just as the soil types are the basis for agricultural practice. The laws of development and growth when once established for a forest type will hold good for the same forest type everywhere, and thus give to silvical deductions the character of scientific truths of a wide application.



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Proceedings

The Society of American Foresters

1907

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Meetings

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1905

November 16. Executive Meeting.

December 7. Executive Meeting.

December 21. Some Philippine Forest Problems.
R. C. BRYANT.

Elementary Instruction in Forestry; Its Possibilities and Limitations.
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1906

January 4. Executive Meeting.

February 1. Executive Meeting.

February 15. Impressions of Japanese Forestry.
GEORGE H. MEYERS.

Striking Features of the Forest and Water Situation in California. E. A. STERLING.

March 1. Executive Meeting.

March 22. Prospective Economies in Forest Utilization.
R. S. KELLOGG.

Forest Photography. GEORGE B. SUDWORTH.

March 29. Factors Determining Stumpage Values.
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Fire Protection Plans. E. A. STERLING.

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to establish a forest cover on denuded portions of the watershed. A recent preliminary examination indicates that planting is advisable on 52,000 acres. The same company is also co-operating in experimental pole seasoning and impregnation. In the upper San Bernardino Valley, the commercial organizations of the several towns and cities have appointed special committees to work up a plan of co-operation which will protect and improve important drainage basins in the adjacent mountains. Their idea is to acquire the private land within the San Bernardino National Forest and plant it, if possible, or, at any rate, have it receive as thorough fire protection as the surrounding public land in the forest. As the adjacent valley is the richest citrus belt of the State, the water question is of prime importance, and the management of the forest of vital interest throughout the region. Mr. Lippincott, the supervising engineer of the Reclamation Service in California, states that the importance of forestry in the upper San Bernadino Valley is hard to exaggerate. In addition to the co-operative work on private lands in southern California, the people of this region have contributed liberally to the public projects undertaken by the Forest Service. Last year the cities of Pasadena and Los Angeles contributed $2,000 for the planting operations in the San Gabriel National Forest, and two private contributions, aggregating $690, were received for fire lines around the plantations and nurseries.

The general situation in California is very encouraging, and it is bound to remain one of the most promising fields for the Forest Service and Reclamation Service. There are many difficulties and drawbacks, however, and the enthusiasm of the people is liable to lead them to expectations which cannot be realized. One of the greatest dangers is the over-production of agricultural products. The great cry is for more water with which to develop the land. This means that there must be a readjustment of market

conditions, and a greater demand built up for staple produce, or there will be a drop in prices which will be ruinous to the producer. This may not come about, but it is not clear how it can be avoided. Most of the output is in the form of perishable fruit, which cannot readily be shipped to foreign markets, while the distance to the eastern markets is a decided handicap. Moreover, the increasing production of similar fruits around Phœnix, Ariz., and at other points farther east, puts strong competition in the field, with an advantage of shorter hauls, and earlier shipments. Despite the boosters' assertion to the contrary, orange growers, on the whole, have made little profit the last two years. In some cases the expense of picking and transportation has reduced the net profit to a ridiculous figure. In one instance, a grower cleared fourteen cents an acre, and another $1.47 a carload. The railroad companies are largely responsible for this, as their charges are exorbitant. Another industry which is unpromising is olive growing. Cotton seed oil is imported and reshipped as olive oil to an extent which makes an olive grove a veritable "white elephant." Ripe olives command only $35 to $40 per ton, and as it costs about $20 to pick them, most of the fruit is left on the trees.

Another direction in which public interest is liable to go astray, is in the anticipated value of a forest cover on the barren mountains of southern California. A forest cover is certainly of high value, but that it will solve the whole water question is extremely doubtful. There are decided limitations to forest planting on all of the mountain slopes, and only on certain situations is it entirely feasible. There is an ample field, however, for immediate operations, and in the meantime, we may learn whether a good chaparral cover, such as fire protection would insure, is as good as the best forest cover which could be produced

on the unfavorable sites. Along streams and on the cooler slopes, forest planting is no doubt practical, and this year's work indicates that the cost can be reduced to a reasonable figure. It will be necesasry, however, to shatter the dreams of those who expect to see a solid forest cover on all the sun-baked mountains around the Los Angeles Valley. The enthusiasts should also be impressed with the fact that fire protection is the first step, and that the cooperation of every resident of the region is needed to secure this end.

From the standpoint of water alone, the mountains of southern California are very unsatisfactory. The streams are short, and the slopes steep, which gives a drainage basin of small area, and few suitable locations for storage reservoirs. Coupled with this is a poor cover and deficient rainfall. The orange groves around Riverside and San Bernardino are largely irrigated by underground waters, which are stored in the gravelly formation which has washed in from the mountains. This is a reserve supply which is liable to be overdrawn, and the area on which underground waters can be obtained has already been reduced about one-third, and the water level in places reduced many feet. In years of drought, such as have prevailed for about a decade prior to 1904, the amount of water used has exceeded the total precipitation in the entire region, including the adjacent mountains. This means a serious drain on the reserve supply, and it is bound to be exhausted unless increased by seepage water from the mountains. A good forest cover thus becomes of high value in preventing the surface waters from passing to the ocean floods.

The local situation clearly indicates that the improvement of the cover on the mountains would be of high value in conserving, and perhaps slightly increasing, the water supply, but a greatly increased supply can be obtained only

from far distant sources. A project is now on foot to divert water to southern California from Owens Lake through a canal, 240 miles long, which must pass over or under three mountain ranges, and across the Mohave Desert. The estimated cost is $23,000,000.

In the northern part of the State, and to a lesser degree in the southern, the proposed projects for the increase or control of the water supply promise to be defeated or hindered by the inevitable attitude of private timberland owners. The National Forests, to be sure, cover an enormous area, and are advantageously situated. Much of the best timber, however, both within and adjacent to the forests, is in private hands, and it will be cut without regard to the influence on the water situation. The Sacramento Valley is one of the most promising fields for irrigation in the United States, and several streams flowing into the valley are being investigated as to their suitability for water storage purposes. In conjunction with this, plans are being formulated for the control of flood waters in the Sacramento River, which now do great damage. All these projects are bound to be mightily influenced by the lumbering operations carried on along the headwaters of the tributary streams. Chico and Butte creeks in the upper Sacramento Valley, and American in the lower part of the valley, are within an area of active lumbering operations, and their flow will necessarily become irregular and difficult to control. Two companies own practically all of the timber along the American River, and are fully aware of the damage they are doing, but economic conditions permit of no change. Another difficulty is the indifferent attitude of many lumbermen towards the fire question, and it will be hard for the State or National Government to satisfactorily control this evil until the hearty co-operation of individual timberland owners is secured.

These handicaps are not pointed out in a pessimistic spirit, but rather to show that too much should not be expected, and that much consistent, practical work remains to be done. With one and one-half million acres already irrigated, and water enough in the State to irrigate seventeen million more, the future is bright. Compared to other States, the attitude of the people is excellent, and the work accomplished of striking magnitude. Although dangerous in some respects, the enthusiasm shown is well grounded, and needs only proper direction to have an influence which will place California well in the fore of other States in matters of water supply and forestry.

SOME FOREST PROBLEMS IN HAWAII

RALPH S. HOSMER
Superintendent of Forestry of the Territory of Hawaii

Delivered before the Society April 26, 1906

The forest question has in the last few years received a notable share of attention in the Hawaiian Islands, and is to-day one of the vital issues in the Territory. The purpose of this paper is to outline the existing situation and to bring together some observations on the problems that confront the forester in that section of the United States.

Perhaps, in the way of an introduction, a general statement in regard to the Territory of Hawaii may not be out of place. The Hawaiian Islands lie in the mid Pacific just within the northern tropic, or, to be more exact, between 18° 54′ and 22° 15′ north latitude and between 154° 50′ and 160° 30′ of longitude west of Greenwich. Honolulu is 2,100 miles from San Francisco; the average time for the steamer trip is five days and a few hours. There are eight inhabited islands in the group, while a chain of islets, reefs and shoals extend for fifteen hundred miles and more to the westward. If distance between boundaries were alone considered, the County of Oahu, with which these small islands are classed, would easily be the largest in size in the United States. For it must not be forgotten that when Hawaii was annexed, in 1898, it came in as a territory — an integral part of the Union — with, indeed, certain privileges not enjoyed by the territories in the southwest.

The five main islands of the group have a general trend from northwest to southeast, lying as follows: Kauai, Oahu, Molokai, Maui and Hawaii. Of the other three, Niihau lies to the southwest of Kauai; Lanai and Kahoo-

lawe to the west and south of Maui. The gross area of the eight islands is 6,449 square miles, which about equals four-fifths of the area of New Jersey. Hawaii, the largest of the group, has an area of 4,015 square miles, or about four-fifths of that of Connecticut. Maui comes next with 728 square miles, while Oahu, Kaui and Molokai have respectively 600, 544 and 261 square miles.

Hawaii is a country of varied topography. On Maui, Mt. Haleakala rises to an elevation of 10,032 feet, while on the Island of Hawaii, Mauna Loa and Mauna Kea are respectively 13,675 and 13,825 feet above sea level. The last named peaks are usually snow-capped during the winter months and even in summer patches of snow may be seen on their higher slopes. In general, the windward or northern sides of the islands are much bolder in topography than the leeward, due in large part to the erosion resulting from the heavy precipitation that comes from the northeast trade-clouds. High bluffs and deep cut gulches are characteristic features of this side of the islands, and with the dense tropical vegetation, add much to the picturesqueness of the scenery.

According to the census of 1900, the population of the Territory as a whole was 154,001. The population may be roughly divided by nationalities as follows: Hawaiians and part-Hawaiians, twenty-four per cent; Asiatics, fifty-six per cent; whites (including Americans and Europeans), seventeen per cent; remaining foreigners, three per cent. The population of Honolulu, the capital and chief city, was, in 1900, 39,306. Honolulu is situated on the leeward side of Oahu. Other towns of importance are Hilo, on Hawaii; Wailuku and Lahaina, on Maui; and Lihue, on Kauai.

The production of sugar cane is the main industry of the Territory, and dominates all departments of industrial life in the islands. There are in all fifty-three sugar planta-

tions, with outputs varying from 260 to 39,000 tons (2,000 pounds) per annum. The total raw sugar produced was 426,248 tons. The average yield of commercial sugar is about twelve pounds per hundred pounds of cane, and the average yield of cane per acre is about forty tons. Expressed in a different way, this is between four and five tons of sugar per acre. For the 1903 crop, the average yield for all plantations was 4.69 tons of sugar per acre. In Hawaii the cane crop takes, as a rule, from eighteen to twenty-two months to mature, when it is cut and allowed to sprout, or "ratoon," one or more times. The raw sugar is shipped around the Horn to Atlantic coast points, or to California. So far, there is only one refinery operating in the Territory. The price of raw sugar fluctuates between $60 and $100 a ton. For some time now, the price has been in the vicinity of four cents a pound, or from $75 to $80 per ton.

Other so-called "allied industries," which are being gradually developed on land not suitable for sugar cane, are pineapples, sisal, bananas, coffee and vanilla; while the prospects seem good for tobacco, rubber, and sub-tropical fruits, when the right men with sufficient capital come to take them up.

Owing to its isolated position, Hawaii has to face many grave problems that do not exist for mainland communities. The statement that "Hawaiian conditions are peculiar" has become trite, but it is nevertheless true, and is a fact not to be lost sight of in any discussion of the islands. The problem of the development of Hawaii centers around the land question and the supply of labor. Hawaii is now and has for many years been a country of one industry. The production of sugar cane, as has already been said, dominates the industrial life of the islands. Indeed, except for pineapples, there is to-day hardly any form of business in the Territory but what depends upon, and in

the end is supported by sugar. This has led, not unnaturally, to an affiliation of interests, until now a very small group of men practically control all the business of the islands, not alone the plantations, with their tributary interests, but also the means of local and, to some extent, of trans-Pacific transportation.

The natural opportunities for many of the so called "allied" or "diversified" industries are excellent. But with existing conditions of lack of adequate local markets and the absence or almost prohibitive cost of suitable transportation facilities, their development is sadly handicapped. Consequently they do not attract outside capital, and without at least some capital, attempts to profitably develop any of these industries are futile.

Until very recently, local capitalists have been content to put all their money back into sugar, although of late it is beginning to be realized that a country with but one industry is in an economic situation that, to say the least, is unsatisfactory. Especially is this true of Hawaii in view of the possibility of Cuban annexation — and its subsequent effect on the American sugar market — which is now looming up large on the horizon.

The foregoing statement is not at all an attack on the plantation interests of the Territory, for it is perfectly recognized that without sugar Hawaii would to-day be little better than a coaling station; nor is it in the least intended to decry the fearless initiative and liberal-minded business policy that has made possible the sugar industry of the islands; that has brought under a high state of cultivation great areas of what would otherwise be waste land; that has been developed, wholly at private expense, elaborate irrigation systems; that has built some of the largest and most perfectly equipped sugar mills in the world; that has, in short, given Hawaii the high place that the islands hold as a sugar producing country. This statement is not made to decry

the plantations. It is merely an attempt to set forth truthfully the facts that the Territory faces in its desire to Americanize the islands.

Now a word as to labor and to land. Up to the time of annexation the laborer on the plantations was Chinese — cheap, hardworking, on the whole eminently satisfactory to the planters. With annexation, Chinese immigration ceased and it became necessary to look elsewhere for labor. As to the result of continued experiments, begun many years prior to annexation, of bringing to the islands colonies of many different nationalities, the plantation labor is to-day Japanese — fifty-six per cent of the total population in 1900 being Orientals. But while on the whole good labor, these people are decidedly not the material out of which to build up a typical American community.

The solution of the problem of Americanizing the Territory lies in the introduction either of colonists from the mainland or of some people capable of being assimilated. And here, as the typical American homesteader is a man of small means, one comes face to face with such obstacles as the absence of local markets, difficulties of transportations, and the more or less open hostility of the corporate interests toward any industry that may divert labor from the plantations.

The problem is further complicated by the part that is played by the land question. Due to its topography, Hawaii has a unique system of land sub-division. In the old days, to insure the rights to fish, to grow taro, to pasture a few head of stock, and to get wood from the forest for canoes and other purposes, the land was divided among the chiefs in long strips running from the seashore up to the ridge or peak of the mountain. As the islands are roughly circular or oval in shape, the lands are thus usually wide below, tapering to a point above. A classification so utterly at variance with the rectangular sub-division of

the U. S. Land Office makes it impossible to apply the United States land laws without considerable modification, even were it wise to do so, which is greatly to be questioned.

The present land law of the Territory dates from 1895 and is the result of long experience in island conditions. By act of Congress, it forms a part of the Organic Act establishing the Territory. The present law is the subject of frequent criticisms, but when these come to be sifted, most of them are found to be directed against its administration rather than against the law itself. An exception, however, should be made regarding the five-year lease on agricultural lands and the thousand-acre clauses. The former is distinctly harmful to the Territory, because in Hawaii it takes the best part of five years to get a new agricultural industry to a point where it pays. As it is now, a new-comer may, by a higher bid, step in and reap the benefits of the man who has borne the brunt of the work. Furthermore, many of the island crops, especially sugar, are grown on a two-year basis that cannot be adjusted to a five-year lease. The thousand-acre clause, designed to prevent corporations from acquiring large areas of public land, while it works no particular hardships on anyone, is easily evaded and has become a dead letter.

One of the characteristic features of the Hawaiian land problem is the leasehold system, which obtains both on government and on private lands. A little over two-fifths of the total area of the Territory still belongs to the Government — 1,720,000 acres; a smaller proportion than is sometimes assumed in discussions of Hawaii. Of this area, much is unquestionably waste land — the present Commissioner of Public Lands estimates 500,000 acres — barren lava flows and rugged and inaccessible mountain sides. One million acres are classed as forest and grazing lands; the remainder, 220,000 acres, is agricultural

land. Incidentally, it may be said, too, that the majority of the best lands in the Territory, both as to situation and fertility, have for many years been in private ownership. From the rentals obtained for its arable and grazing lands and for water rights, the local government derives no inconsiderable part of its revenue; the amount last year being $130,763, out of a total receipts of $2,354,813.

All of the best land has been taken up and is now under lease, and practically the entire area on which cane can be profitably grown, on government as well as on private land, is under cultivation. But the existing leases are continually running out, so that from time to time large areas of government land become available for redisposition.

Two methods of establishing a citizen population present themselves and are now being acted upon by the local government. One is to open up government land to homesteaders, as the leases expire, in sufficient area for one family to cultivate; the other is to give an acre or two for a home, with the expectation that the settler will work for the neighboring plantation. While theoretically the first plan is excellent, it has not worked well in practice. On some of the homestead tracts the physical conditions, combined with the ever recurring difficulties of transportation and market, have not enabled the settler to make a bare living with any of the diversified crops. And where he has tried to grow cane, the result has usually been that before long he was frozen out, while his land either reverted to the Government or went to the plantation to satisfy a mortgage; in either case defeating the object of the law. One notable exception is the Wahiawa Colony, a group of Californians on Oahu. These men have been successful, and have made their tract the center of the pineapple industry. But the Wahiawa people brought to their undertaking, business ability and capital much in excess of that usually possessed by the average Hawaiian homesteader.

The case of Wahiawa merely emphasizes the point already made that undoubted opportunities are present for those who are in a financial position to take advantage of them.

The other type of homesteading gives promise of more immediate results, the more so as several of the plantations are settling homesteaders on their fee-simple lands. Properly conducted, this type of homesteading might gradually, through some equitable system of profit-sharing, be made to lead into the growing of a considerable part of the crop by individuals, while the corporation operated a central mill at which the cane was ground, with only sufficient fields of its own to insure a steady and uniform supply. This plan is already being tentatively tried. Locally developed, it will in time build up the middle class so much desired, while if at the same time capital, local or otherwise, can be made to see the profits which lie behind the systematic development of the diversified industries, room will ultimately be made for the small landholder, for the local economic conditions will be such as to allow him to make a comfortable living from his farm. But these reforms cannot be inaugurated suddenly without endangering the whole economic fabric of the Territory, for the existing usages are deeply rooted and bound up with the very life of the islands.

Such, then, is the problem; and as the forest question in Hawaii is but a part of the greater question of the best disposition of the public lands, plans for the betterment of existing conditions become quite as much a part of forestry as is the more technical work of studying or planting trees.

The forests of Hawaii are of two general types, the native forests on the slopes of the mountains, and the algaroba forest on the lower levels on the leeward side of each island. The algaroba (*Prosopis juliflora*) was introduced into the islands in 1837 by Father Bachelot, of the Roman

Catholic Mission; the first tree planted still stands on Fort Street in Honolulu, bearing a tablet appropriately inscribed. In Hawaii, the algaroba grows to be a fair-sized tree. It is of importance for its wood, largely used for fuel in the islands, and for its pods, valuable for stock feed. It has now spread so that it covers large areas on the leeward side of each of the larger islands from sea level up to an elevation of 1,000 feet or more, and it is gradually spreading higher. Algaroba will not grow where exposed to the trade winds.

The native forest as it exists to-day covers all the mountainous land above an approximate elevation of from 2,000 to 2,500 feet, varying with the locality, on the islands of Kauai, Oahu and Molokai, and on Maui and Hawaii in a belt more or less completely surrounding the high peaks between the approximate elevations of 2,500 and 6,000 feet.

The Hawaiian forest consists of a variety of trees, of which the most important, both numerically and commercially, are the ahia lehua (*Metrosideros polymorpha*) and the koa (*Acacia koa*). Koa, unfortunately, is the only wood at present having economic value other than fuel. Koa is a heavy, close-textured, light-colored wood with a beautiful grain, susceptible of high polish, and with a satiny gloss that makes it peculiarly adapted for certain kinds of interior finish and for furniture. Some trees have, further, a curley or wavy grain which gives the wood the effect of watered silk. Koa is now being systematically put upon the mainland market under the name of "Hawaiian mahogany." It closely resembles West Indian mahogany in texture or working.

The best koa is found in a belt lying between the elevations of 4,000 and 6,000 feet on the slopes of the higher mountains. Here it reaches a total height of 100 feet or over, with from forty to sixty feet of clear length, and a

diameter, breasthigh, of from two to seven feet. It is in this koa belt that the logging operations are now going on. The company organized to lumber the koa is working under a contract with the Bishop Estate which contains provisions looking to the future welfare of the forest. It is needless to say that I am keenly interested in the success of this venture, because it will, I believe, result in much permanent benefit to the Territory. Koa is also found at lower elevations than the typical koa belt, but in these localities it has a spreading habit and is not so well adapted for commercial utilization.

Ohia lehua is a heavy, close-grained, extremely hard wood, for which it is hoped a market may in time be found. At present ohia is only used for fuel, but for this purpose algaroba, being more easily got, has largely driven it out of the market. Ohia lehua has been used somewhat for railroad ties, especially on curves, as it holds the spikes very firmly. It lasts better under cover than in the open; indeed, if properly seasoned it is, when protected, almost indestructable. Of late, a company in Hilo has undertaken the manufacture of ohia telephone insulator pins, which, from tests made in that rainy city, give promise of excellent results.

This lehua makes up the bulk of the Hawaiian forests, both at the lower and the higher elevations, forming something over half of the trees in the mixture. There are several forms of the tree, distinct in habit of growth and other characteristics, although the differences are said by botanists to be varietal rather than specific. There are many interesting botanical problems waiting to be investigated in the Hawaiian forests. A systematic study of the ohia lehua is one of the things which should be early taken up.

Many trees yielding wood valuable for cabinet work are found in the Hawaiian forests, but the more important ones are so scattered as to make their commercial utilization out

of the question. Later, when the forests are brought under a definite system of forest management and control, it will be a problem worth working out to see if some of the species yielding the better woods cannot be made to grow in stands sufficiently dense to repay the cost of logging.

The same statement applies to sandalwood (*Santalum freycinetianum*), which in former days formed the basis of a considerable industry, the wood being exported to China in exchange for all sorts of East Indian commodities. Owing to the extreme vigor with which the petty chiefs forced the common people to get out sandalwood, the species was very nearly wiped out, through over-cutting and incendary fires, so that to-day only scattered groups of sandalwood are to be found. The Hawaiian sandalwood was in the main used for incense, and even before the supply gave out, the price had considerably declined. It is often asked why the sandalwood trade is not revived. The problem is an interesting one which deserves to be carefully looked into. Whether or not it would pay to try to raise this tree commercially is a question that can only be settled after a thorough study.

Of the remaining trees, the kukui (*Aleurites triloba*) is a very noticeable species, from its light-colored foliage, which adds another characteristic shade to the already great variety of greens. In former times an illuminating oil was obtained from kukui nuts, and the nuts themselves, strung on the mid-rib of the cocoanut palm leaf, were used as torches. Kukui oil is said to be a good lubricating oil, but it has never been extracted in commercial quantities. Otherwise the tree has no economic value.

Undergrowth in the ohia and koa forests is made up of a great variety of tree brakes, and other ferns, climbing vines, and shrubs of many kinds, which with the low-growing ferns make an almost impenetrable mass of vegetation, and create nearly ideal conditions for the conservation of

water. Its importance as a protective cover on the principal watersheds is, indeed, what gives to the Hawaiian forest its greatest value.

Higher in elevation than the dense forest just described are scattering groups of ohia and koa trees, and an open stand of mamani (*Sophora chrysophylla*). This species runs to about 8,000 feet elevation. Above this a low growth of shrubs continues to the limit of arborescent vegetation, about 10,000 feet. On Mauna Kea there are large areas of sandy soil above 8,000 feet, which should be able to support tree growth. There is apparently no good reason why coniferous trees from the temperate zone should not do well here, if once started. In view of the scarcity of construction timber in the islands, such a forest would be of great economic importance. The opportunity here afforded, leading as it might to results of far-reaching importance, is one of the most tempting forest problems in Hawaii. It would seem that the most feasible way of establishing a coniferous forest at this elevation would be through seed spots, but at present nothing can be said definitely about the matter.

There are as many stretches of waste land at lower elevations, especially on the Island of Hawaii, where lava-flows have from time to time come down the mountain side. Some of these have begun to disintegrate and might be made to grow certain kinds of trees. Others, though over a century old, appear as fresh as if the lava had but just cooled. The upper slopes of Mauna Kea, the older mountain geologically, have in general a sandy soil.

The prime value of the Hawaiian forest, however, is not in its commercial value, actual or potential, but in its importance as a protection forest on the watersheds of the streams needed for irrigation. Successful agriculture in Hawaii, as in most essentially agricultural tropical or subtropical countries, is dependent on an abundant supply

of water. Where this is not obtained naturally through a copious rainfall, irrigation is necessary. Accordingly, to supply the needs of the less favorably situated districts, elaborate systems of ditches, tunnels and flumes have been built on each of the four larger islands to convey to the plantations the water demanded for the success of the growing crop. On the windward sides of the islands where the precipitation is ample the streams are turned to account for the development of power or for fluming cane to the mill. With water playing the important role that it does, it is therefore but natural that the main efforts in forest work in Hawaii should be directed toward the creation of forest reserves — protection forests on the catchment basins.

Most of the land that is desirable to be set apart as forest reserves is not suitable for any other economic use. Some of it might be utilized for grazing, while other portions which it is now considered advisable to include within the reserve boundries may in time, with better conditions of market and transportation, be developed for agriculture. As the forest question is in reality a part of the greater public lands question, as has already been pointed out, and as the rentals from the lease of government lands is an important item in the revenue of the Territory, it follows that it is only right and proper for the Commissioner of Public Lands to be jealous of everything which may encroach upon this source of revenue or interfere, through its diversion for any other purpose, with land that could be leased or opened for settlement. In the creation of the forest reserves, it is therefore of prime importance that the boundary lines be so drawn as not to interfere with revenue-producing land or areas which it is possible and wise to develop in the near future for any form of agriculture, except where the necessity for stream protection is so unquestionably evident as to justify including land

that could be used for these purposes. While the immediate benefit of the Hawaiian forest reserves may appear to be to the plantations, the reason for their creation lies deeper, for in Hawaii, as elsewhere in the United States, the fundamental purpose of forest reserves is to make possible the building up of the country through permanent settlers.

The forest work of the Territory is carried on by the Division of Forestry under the Board of Commissioners of Agriculture and Forestry. The Board is appointed by the Governor, and consists of six members, who serve without salary. Under the Board are divisions of Forestry, Entomology and Animal Industry, and a certain portion of the Board's appropriation is expended for agricultural investigations in co-operation with the Federal Experiment Station.

The share of the Board's appropriation allotted to the Division of Forestry for the present fiscal period (July 1, 1905, to June 30, 1907), is $9,450 per annum, of which $5,000 is for salaries on the statutory roll and $4,450 for general and incidental expenses; the additional sum of $1,000 per annum is also expended through the Division of Forestry for the introductin of seeds and plants new to the islands. The staff of the Division of Forestry now consist of the Superintendent of Forestry, who by statute must be a professional forester of experience, and one assistant, the Forest Nurseryman. There are also throughout the Territory some two dozen District Foresters—plantation managers and other gentlemen who give their services and assist in carrying out the provisions of the forest law. Paid forest rangers have, with one exception, not yet been appointed, although by the co-operation of certain of the sugar plantation companies arrangements have been made whereby employes of the corporation act as rangers. This is perhaps the most serious need in the forest work

in Hawaii, and every effort will be made to secure an increase of appropriation from the next Legislature sufficient to permit the employment of an adequate force.

The work of the Division of Forestry naturally falls under two general heads: the creation of forest reserves, and forest planting; the latter including as well the introduction of new or important trees and shrubs of value to the Territory. The procedure of creating forest reserves may be briefly described thus:

Following an examination by the Superintendent of Forestry, the results are presented in a written form, and the Board recommends to the Governor the permanent reservation of a certain area as a forest reserve. It requests him to set apart as compartments thereof the lands not under lease, owned by the Territory, within its limits. A public hearing is then held, and if no serious opposition develops, the Governor declares by proclamation that the area within given boundaries should be permanently maintained under forest cover and definitely sets apart the unleased government lands therein. The result in a way resembles the classification in use in the Adirondack Park in New York; as the government lands actually set apart bear much the same relation to the reserve as a whole as do the lands constituting the Adirondack Forest Preserve to the total area of the Adirondack Park.

Up to the present time (April 26, 1906), eight forest reserves have been created with a total area of 249,472 acres, of which 69,566 acres of government land have actually been set apart. Reserve projects covering approximately 150,000 acres are before the Board for final action, most of which will without question be speedily put through. As the proportion of government land is larger in the projected reserves than in some of those already created, the total area actually set apart will soon be largely increased.

Through arrangements with the owners of neighboring

land, and by the insertion of clauses in the leases of adjoining government lands requiring the building and maintenance of fences along the forest reserve boundaries, cattle are in large measure excluded from the reserves. And through the interest and co-operation of the private corporations which use the water coming from the reserves, the danger of forest fire is minimized.

The majority of the owners of forest land are heartily in favor of forest reservation and several of them, notably the Bishop Estate, Alexander and Baldwin, the Hawaiian Agricultural Company, and the Lihue Plantation Company, have for many years maintained private forest reserves. Under the law, the Board is empowered to assume the management of forest land turned over to it by corporations, but, so far, owing in large part to the lack of a forest ranger service, the corporations have been unwilling to turn the management of their lands to the Division of Forestry, preferring themselves to care for them. The reason why it is desirable that the management of private lands should be transferred to the Board is that thereby an organic system of forest administration could be put in force, which in the long run would give better results than can the present management, where a number of perhaps conflicting interests attempt to manage an area which, to secure better results, should be subject to one central control.

The pressing need now is for the establishing of an adequate system of forest reserve administration to care for the reserves, to protect them from injury, and gradually, whenever that may be possible, to put them on a self-supporting basis.

The second main branch of the work in the Division of Forestry is forest extension. There is great need in Hawaii of a local supply of construction timber and of wood suitable for railroad ties and fence posts. To supply this demand, many trees have been planted throughout the Ter-

ritory in the past thirty years both by the government and by private corporations. As the indigenous trees are mainly of value as cabinet woods, exotic species have been largely used in this work. The Australian trees have given the best results, notably several of the eucalypts, the ironwood (*Casuarina*), the silk oak (*Grevillea robusta*), and one or two of the wattles (*Acacia*). During the coming summer it is expected that some definite figures on the production of wood in Hawaii, including the cost of growing and money returns, will be obtained. These figures will be published in the form of a bulletin and will be the first definite information available on this subject, for it is only recently that the planted trees have reached sufficient size to assume economic importance. Considerable area of artificial forests have been established in past years in the vicinity of Honolulu through government appropriations, both on Tantalus Heights and in Nuanu Valley. This planting was discontinued some three years ago owing to lack of funds. Valuable as were the results obtained, if the Government again undertakes tree planting it will be on the other localities and under a more systematic plan of operation than obtained in the earlier work.

Practical work in the forest extension is now being done through co-operative assistance to tree planters — a branch which it is expected will from now on form a prominent part of the activity of the Division of Forestry. A circular has recently been issued offering the advice and assistance of the Division to persons desiring to do forest work. This circular is based upon the offers made familiar by Circulars 21 and 22 of the Forest Service and is similar in character to them. For the benefit of individuals and corporations desiring to establish forest plantations, the Division of Forestry keeps constantly on hand fresh seed of the most important native and introduced trees, and also a limited number of seedling trees. The seed and

plants are sold at prices just covering the cost of collection or growing.

Experimental work leading to the introduction of new trees is another line of investigation capable of very great expansion. At present the Division of Forestry does what it can through co-operation with volunteer assistants, who agree to care for and plant out in different parts of the Territory forest tree seedlings furnished by the Division. Later, it is expected that regular sample work can be undertaken.

All over the Territory there are various interesting problems waiting to be solved. In the fields of dendrology and silvics the ground has hardly been broken, while in the way of other scientific forest investigations leading to practical results there is very much that waits to be done. Because of the peculiar relations between topography and local meteorology in Hawaii, a favorable opportunity exists for gathering data that could perhaps throw some light on the much mooted question of the influence of forest upon local rainfall. It is certainly to be hoped that some of this work can be undertaken through Federal assistance, for it seems unlikely, in view of the constant demand upon the limited resources of the Territory, that sufficient appropriations can be secured to enable the prosecution of such work, and it will necessarily be a long time before enough revenue can be derived from the forest reserves themselves to permit of this character of study.

The question of forest fires is a serious one in Hawaii, for although a humid country, there are frequently periods of fire danger, during continued droughts. At the last session of the Legislature a forest fire law, closely modeled upon that prepared for the state of California by the U. S. Forest Service, was enacted and gives promise of working well, although another bill appropriating money for carrying out the provisions of the fire law unfortunately failed

to pass. However, under the law passed, district fire wardens have been appointed and cloth warning notices prepared and generally posted throughout the country. By these means it is hoped that public sentiment can be aroused and not a little done toward preventing fires.

Altogether, the outlook for forestry in Hawaii is bright. There is an excellent public sentiment in favor of the movement, especially among the influential men who control the great corporate interests. There is a great deal of the most interesting kind of forest work to be done, and although no decided increase in appropriations can be expected, it is believed that with a proper presentation of the needs of the forest work, sufficient money can be got to insure the accomplishment of the essential things.

With the continued support of the local public and with the backing and co-operation of the U. S. Forest Service, the Division of Forestry of Hawaii may hope to be able ultimately to accomplish many of the objects that it has in view.

SOME PROBLEMS IN FOREST EDUCATION

PROFESSOR HENRY S. GRAVES

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The character of work done in a profession is closely dependent on the training schools. This is true of the science of forestry no less than of medicine and engineering. If there are good forest schools, there will be good foresters; if the forest schools give inadequate instruction, the defects will be apparent in the progress of the science and in the results obtained from its practice. The question of forest education, therefore, is a very vital one for the future of forestry, and it is of the greatest importance that our schools have good teachers and that they teach the right things in the right way. There is at the present time a lack of agreement as to what are the right things to teach and the methods of instruction are also a subject of controversy. There are many problems occupying the study of those engaged in forest education which I cannot touch upon in a short paper. My talk will concern chiefly some fundamental questions of the thoroughness and extent of forest education needed in this country, and the methods of instruction.

The first question to be answered in establishing a school of forestry is the extent of technical education necessary for American foresters. The fact that the conditions in this country are different from those in Europe, and that forestry cannot in most cases be practiced as intensively, has led some to believe that an American forester does not need as extensive a technical knowledge as the German or French forester. In fact, some have gone so far as to say that forestry in this country is essentially exploitation or lumbering, and that the forester must be trained primarily

as a lumberman, with perhaps a smattering of the principles of forestry. I believe that such an opinion can only be the result of ignorance or false interpretation of our conditions and forest problems, or an ignorance of the scope and nature of forestry.

There are really three classes of students requiring consideration by forest schools: (1) Those who intend to enter public service or to practice forestry on private lands; (2) Lumbermen who have little regard for the productive side to forestry; (3) Forest rangers and woods superintendents. If the requirements of these three classes of students be kept distinct, much of the confusion and disagreement regarding forest education will disappear.

Hitherto, attention has been given chiefly to the first class to foresters. It has usually been considered that men going into the lumber business would require no school training; and the third class of foresters, the rangers and woods superintendents, have received but little consideration from the schools. As my paper will deal for the most part with the problems of higher education in forestry, let us consider first the training of the forest rangers and lumbermen.

The work of the forest rangers must be more or less local in character and, therefore, special schools should be established in different parts of the country. It would, in my judgment, be a mistake to establish a central school in the East for the training of both eastern and western rangers. Eventually the rangers on the National Forests will be recruited from men who have had training for that service. I believe that the establishment of schools suited to the needs of forest rangers would result in a great increase of efficiency of the Service. Such schools should, however, be established in the West, and should be conducted along very practical lines under the direction of those who are familiar with the work which the western

ranger must carry on. The new school at Colorado College is contemplating just such a ranger course.

The private forest problem in the East will be worked out largely through local woods superintendents or foremen. The average private owner cannot afford to have a trained forester constantly on the ground. Moreover, it is unnecessary, for the actual work can be conducted by a competent foreman under the general direction of a trained man. Such foremen should be of the same general character as the rangers of the West — that is, men who are thoroughly familiar with the woods, are able and willing to chop timber or drive a team when necessary. It is entirely unnecessary that the ranger or woods foreman should have an elaborate training in theoretical forestry. The eastern woods foreman, just as the western ranger, should, however, have enough knowledge of the theory and practice of forestry to appreciate its aims and to be able to handle the work of tree planting and ordinary cutting made according to the principles of forestry.

I believe that ultimately it will be wise to organize a course of at least one year for the training of such men. The work should be largely conducted in the field, and the school located in connection with a forest under actual management, where there would be an opportunity not only for general field instruction but for practice in the actual work.

The short course given by Yale at Milford, Pa., is being shaped to meet the special requirements of eastern rangers and woods foremen, but no attempt has been made or will be made to encourage western rangers to attend the course.

One of the most interesting things in the recent development of forestry is the change in the attitude of lumbermen. Lumbermen are beginning to appreciate the practical value of a knowledge of forest technology, surveying, forest protection, forest law, and forest measurements,

not merely for foresters in public service, but for those in the lumber business. It is one of the functions of a forest school to provide instruction which will meet the peculiar requirements of those preparing for the lumber business. The first impulse would be to organize a one-year's course, comprising surveying, mechanics and machinery, forest products, forest protection, law, road construction, forest measurements and lumbering, with general superificial courses in silviculture and forest management.

In considering this problem, one must keep in view just what kind of work the lumberman will have to do. Is it his purpose to prepare himself to work into a high position in a company, not merely to do executive work, but also that of administration and organization? Presumably, yes. If this is not his object, a one-year's course like the ranger course is enough. Experience in developing the course in lumbering at Yale, in co-operation with our practical advisers from the National Lumber Manufacturer's Association, has strengthened my conviction that the young man preparing for the lumber business should take practically the same course as the high-grade forester. The differences that we shall make in the work offered to the two classes of students will probably be in restricting somewhat for the lumberman the work of scientific research. As our course is not yet entirely worked out, I shall not discuss this problem now more than to say that we shall maintain a high educational requirement for admission for the student aiming toward lumbering, and our policies in the matter of methods of instruction will be identical with those described later in this paper for technical forestry.

The problems which I wish chiefly to present to you are connected with the education of *foresters* as distinguished from *lumbermen* and *forest rangers*. It is my belief that American foresters require fully as good, if not a better training, than European foresters. In many cases the

field of the professional forester in this country is broader than in Europe, where the work is now along more or less beaten tracks. In this country the profession is new. The public is not educated up to the necessity of protecting its forests, and consequently the difficulties of forest protection are very great; there is in many regions an adverse sentiment; there is no empirical knowledge of how to handle our forests; there is no adequate knowledge of the silvical character of our forests, including their growth and yield; there is a great lack of trained men of different grades, and the market conditions often render our problems very difficult. The work of establishing forestry on a practical and broad foundation in this country, the development of new policies in the States and in the Central Government, development of silvicultural policies in organizing forests, the securing of adequate State and Federal legislation leading to the protection of our forests and for the encouragement of silviculture, the organization of forest bureaus in the various States, and the problems of handling large private tracts, the scientific study of the life history of our trees and forests, and finally the questions of forest education, are problems which can be handled only by men of the proper general education and technical training. Forestry and lumbering are not the same thing in this country. Lumbering constitutes an important part of forestry, but the manner in which our public and other forests are managed is going to depend on something besides a knowledge of how to extract and sell the product.

One sometimes hears the statement that an extensive technical education unfits the student for the practical work. It has been my experience that the blunders in forestry have been made principally by men with an inadequate training and that the question of whether a man is practical or not depends primarily on the character of the

man himself, and secondly, on the quality of the instruction. I consider the doctrine that the American forester need be only half trained is especially pernicious, for it misleads the student and inevitably increases the blunders in forestry, which may have very serious consequences at this time when young men have to be given very responsible work.

The success of a curriculum must depend upon the knowledge, on the part of those in charge of the school, of the forest conditions of the country, and the work which a forester has to do. We have no precedents to follow, and it is necessary to provide instruction from judgment, based in part on what American foresters are now doing, but also on what they unquestionably will have to do in the near future. Foresight is necessary, because the profession is developing so rapidly that the work of the forester may be different ten years from now.

It is natural that the student should prefer studies which appear to him to be very practical. He is often impatient of spending his time in a professional school on work which seems to him to have only an indirect bearing on the application of forestry. A school organized by undergraduates would be minus the auxiliary sciences. It would consist of lumbering, silviculture, forest management, and a little engineering. Granted that a student has a general education sufficient to enable him to carry on the technical subjects of a forest school, what of the so-called auxiliary sciences should be given? In the first place, I believe that a forester should be a surveyor. Any one who has to do with the management of land must be able to use maps, and he ought himself to be able to construct maps. I do not believe that a knowledge merely of how to run a line with a compass is sufficient. The forester must be able to make maps as well. I am convinced from experience that the forest student should have, in the first place, a very thor-

ough course in field surveying, including the use of the ordinary instruments, such as transit, level, plane table, etc., and that he should also be given training in map drawing. At one time it was my belief that a little knowledge of rough surveying would be sufficient for the forester. I do not believe that one can become capable in rough surveying who has not previously had a thorough training in the principles and methods of precise surveying. Since we have introduced thorough work in surveying at the beginning of our course at Yale, I have been interested to note the beneficial effects of that training, not only along the lines of map construction, but also in silvical work, preparation of working and planting plans, and in other work requiring care and accuracy.

The high-grade forest school is often criticised, particularly by laymen, for the amount of botany which is given. At Yale we make a knowledge of general botany one of the requirements for admission. We conduct courses in general morphology of plants, external and internal morphology of woody plants, dendrology, plant physiology, and diseases of trees; and really the courses in silvics and forest technology are botanical in many of their essential features. I am convinced that a forester should know how a tree is constructed and how it grows, in order to study its silvical character. It is true that an extensive training in botany, such as I advocate, will be of very little assistance to a forester in exploiting his product. The present revenues from the Government forests are not going to be increased from the botanical knowledge of the forester, but the future returns will certainly be affected by it. Such knowledge has a direct bearing on the development of methods of silviculture, for this must depend on our knowledge of silvics, and a well-rounded basis of botany is necessary for silvical investigation. We must not forget that silviculture is but a special branch of applied botany. One

is apt to place too much emphasis on the study of *methods* instead of *principles*. If we had methods to study, the case might be a little different; but we have no methods as yet. They must be developed, and their development depends upon a knowledge of how trees and forests live and grow.

Some of the most valuable work in silvics in Europe has been done by botanists, and as far as I know, practically all of the important silvical research has been conducted by those who have had a thorough grounding in botany. Robert Hartig was a conspicuous example of a botanist who specialized in forest studies. I may say that the course which I myself had in anatomy and physiology of plants under Dr. Hartig was of the greatest direct benefit to me in my own scientific studies. Diseases of trees is one of the theoretical subjects which has often been thought of very little value to foresters. It is true that it would be impossible in a course of forestry to develop an expert in diseases of trees, for this is a specialty in itself. I believe, however, that a forest student should have a course in this subject in order to understand the action of fungi on trees and lumber. Those who have carried on work in our second-growth hardwoods have met the problem of how long trees which have been injured by fire may be expected to live and thrive. After such injury, trees are attacked by different fungi, different species have specific resisting power against different fungi, and after attack the action of the fungi is different under different conditions. Here is a difficult silvicultural problem which can be worked out only by a silvical study, and this in turn requires for its complete solution a knowledge of tree pathology.

Like botany, the requirements in geology present an interesting problem. A knowledge of geology is necessary in order to understand soils, and a forester who does not have a knowledge of soils is not in a position to undertake

tree planting; he is not in a position to conduct work in thinnings and other cuttings; and he would be badly handicapped in working out a study of the future production of a large forest. I think that few men would deny the necessity of a student having a foundation course in general geology. At Yale, this is one of the requirements for admission to the school. A forester should be able to identify the common rocks. He should further have a knowledge of physiographic form and types, and understand their correlation with the geological formation. The close relation between physiography and forest distribution is now very well recognized by foresters, botanists, and geologists.

A subject about which there has often been much dispute is entomology. In European schools, entomology is taught in the course in forest protection. It sometimes seems to foresters as if but little benefit could be obtained by a study of this subject, for a knowledge of insects is so special in character that it can be mastered only by those who can devote far more time than is possible for the ordinary forester. The student should, however, understand the main groups of insects which prey upon trees, and their life history. It is plain that the forester cannot hope to be able to identify insects as he does trees, but a general knowledge of forest entomology may often affect the practical management of forests. It has often occurred to me that the spread of insect damage in the Black Hills may be the result of forest protection. The prevention of fires must have permitted the insects to develop more rapidly than previously when fire usually followed cutting. We have protected the forest from fire, but, through a lack of knowledge of forest entomology, did not protect it from insects. Having in mind the needs of the well trained forester in this regard, we are endeavoring at Yale to develop instruction in forest entomology which will give the neces-

sary training and will not involve an unnecessary sacrifice of time.

One of the problems of a school is to obtain competent instructors to give the courses which I have briefly enumerated under the head of auxiliary subjects. A forest school attached to a university has an advantage in having specialists in all these subjects. The best results can be obtained if special courses in these subjects can be given, adapted to the needs of the forester.

One may naturally say when hearing these statements of the foundation work of forestry: "Why not let the specialist take this work and the practical forester take only practical technical subjects?" I will answer this by reference to the work on the National Forests. The Federal forester's work is not merely administrative, it is in part silvicultural. The methods of silviculture are not yet established. The forests must sooner or later be organized on a basis of sustained production, and methods of cuttings be developed which will accomplish this object. In organizing an extensive forest establishment, expediency often requires immediate cuttings before there has been time to study the silvical character of the forests or work out a matured plan of management. With limitations of market and a need of revenue to support the protective service, and with a lack of trained men, very rough methods of silviculture are adopted.

These methods must, however, be followed by systematic silviculture which, with unknown forest types, require silvical studies as their basis. I consider it a very easy thing for a young forester who establishes a rough automatic method of silviculture on a forest reserve, and whose time is occupied with executive work, to draw away from the consideration of better silviculture, working plans, etc. And a young man in this position who has not had a technical training would consider many subjects theoretical and

advise the schools to provide chiefly for the business side of forestry. I do not know whether such a tendency exists among American foresters or not. I should be surprised if it did not. And yet it requires but a moment's reflection to see that a forest officer who cuts blindly without plan, by guess-work, and trusting to fortune for reproduction, is treating his public trust lightly. If he blunders, as he is likely to do, he will deservely be called to account by the people, the owners of the property which he may have grossly, and often in a flippant spirit, mishandled and abused.

The graduates of our schools have a great responsibility in the management of this property. They must be prepared to handle it on economical and business principles, but they have the duty of providing a product, not only 100 years hence, but continuously. As an organizer and director of a forest school, I recognize my responsibility to train the men not only to conduct the business of forestry, but also to safeguard the interest of the people for all time. For this reason we insist on a thorough grounding in the special technical branches of forestry, and also on a solid foundation in the auxiliary sciences.

A perplexing problem in a school is the arrangement of the field instruction. Forestry is essentially a practical subject, and much of the instruction must be given by field work. The balancing of the theoretical and practical instruction is not an easy matter, and it is one in which opinions differ, one school being charged with being too theoretical, another with lacking adequate instruction in fundamentals, and so on. Field work may serve two different purposes: first, to illustrate and fix in mind methods and principles; and second, by repetition and practice in the field, to give facility in applying practical methods. Drawing an analogy from the study of medicine, much of our field instruction is the laboratory and

clinical work of the medical student, the rest is his hospital practice.

At my own school, we give both kinds. Most of the field work during the course is of the first kind; but the last four months of the senior year, after all the indoor work is completed, the students are given their finishing work in forestry and lumbering, comprising a good deal of repetition and practice. One underlying principle is, however, kept in mind, and that is, we do not pretend or hope to supply to the forester what can only come by experience. For example, in the simple matter of stem-analyses, one acquires with every new thousand taken, with every new species worked with, and with every new problem encountered, an experience which adds to his efficiency. But in a school the student cannot be made to take thousands of stem-analyses merely for practice and increased facility. There are too many important things to be learned. The student is given thorough drill in this work by practical field training. When he understands fully how to do it as shown by the results of his field work, he ought to be given other work, and he considers himself abused if such is not provided him.

This principle applies equally well to the field instruction in surveying, in silvics, physiography, lumbering and forest organization.

I have been speaking principally of the technical side of forestry. One of our most difficult problems in forest schools is to prepare men for the business side; to prepare men to organize the business of operating a tract, to buy and sell timber, to be land administrators, and so on. I do not refer here to questions of working plans, maps, and other similar technical matters, but to the actual business of cutting and disposing of timber, and administering property.

This problem is important from the standpoint of every

forester, even one who may specialize in research, though more so for those who will enter Government service or private work as lumbermen and foresters.

We recognize at once that there are certain things which cannot be accomplished at any school. Take for example the question of lumbering. One cannot produce a trained lumberman at any school, but one can prepare a student so that he will work into the lumber business more quickly than otherwise, increase his usefulness, and hasten his success. A graduate of a school of forestry could not at once handle a logging operation, and it ought not to be expected of him. But he can be given a training at a school which would enable him to take up this work readily. One may keep his students a long time at a saw mill, but they can never learn to run a mill until they take it up themselves in a business way. Then one would learn very quickly, having had his previous instruction. A young man who knows wood, who can estimate the quantity of standing timber, who knows how to analyze the factors governing cost of production, who understands the principles of grading, who knows prices, the methods of shipping and selling lumber, etc., etc., has a broad basis to begin his business on that is often gained only by long experience. A young man graduating from such a course and entering the lumber business must start from the bottom like the rest. He cannot begin at a high salary in responsible work. But I shall be surprised if he does not work up to responsibility far more rapidly than otherwise.

This general principle applies pretty well also to training men for work on the National Forests. What special training can be given them for that service? We are trying to fit our graduates to do all the practical woodswork of the Forest officer: To estimate timber, to determine its value by knowing the cost of getting it out, to handle con-

tracts, to make and use maps, to lay out roads, to make working plans, silvical studies, etc. What can we teach them of the National Forests. We are developing at Yale a course dealing with the National Forests. The student will be shown what the conditions are, including the character of forest, the markets, the methods of lumbering, and the work carried on by the Service; the organization and methods of work are explained, the laws learned, and so on. Just as we cannot make trained lumbermen, we cannot make experienced Federal officers. Young men must begin at the bottom and work up. Anyone put into a totally new environment must expect to have to learn the local conditions. A Maine lumberman in Florida must adjust his ideas to the new conditions. A California lumberman might blunder badly if he were to operate in Maine. Often too much is expected of the young graduate. Because he has been in a forest school he is expected to have business judgment and to know all conditions of the country as well as of the region in which he has worked. We endeavor at our school to give them as much woods training as possible, but we cannot make them expert choppers, or give them special training in riding, practice in care of horses and mules, canoeing, snow-shoeing, shooting, camp-cooking, and so on. We encourage all these acquirements, and our men get a great deal of this woodcraft in their woodswork and vacation trips. If they have the right viewpoint and the broad training I have advocated, they can learn the local conditions in a very short time. I look forward to the time when our Forest officers may pass through some sort of apprenticeship, analogous to that required of the young business man. If they could be given some sort of a short apprenticeship, they would acquire the training which cannot possibly be given at school, and the problem of education of Federal officers would be much simplified.

I do not believe that we should try to teach tricks of the

trade at the expense of solid training in principles; we should not spend weeks in training men in things which they will acquire much better in a few weeks or even days later; we should give systematic training in things which the student cannot, or it would take a long time to, thoroughly acquire in practice.

We need in forestry, broad-gage men, capable of large constructive work. Let us give our students the right foundation of education and our profession will be strong and our foresters will have the confidence of the country and be capable of handling the immense interests, public and private, which we wish to have intrusted to us.

OBJECTS AND METHODS OF ESTABLISHING PERMANENT SAMLPE PLOTS

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I. Importance of Permanent Sample Plots

The object of this paper is to emphasize the importance to forestry of a line of scientific work known as "permanent sample plots," and to describe objects sought and methods pursued. The importance of scientific work in silviculture has only recently been fully recognized in India, where there was established during the past year a research institute, in connection with the Dehra Dun Forest School, with a special staff of five experts for investigation work. The duties of this new staff, as stated in an editorial in the *Indian Forester*, consists in the study of the silviculture of trees, and other purely scientific work which cannot be performed by the officers engaged in ordinary executive duty, as they have too much to do already.

It is well that the Forest Service is about to follow the example of India in creating a section for purely scientific investigation in silviculture, so as not to have to rely on the overworked executive force on the reserves for detailed and exact silvicultural information.

The sample plot idea was originated by Professor Graves, and work commenced in the summer of 1904. Professor Graves says: "What led up to it was a need for definite silvicultural knowledge, which I felt when I was making thinnings and cuttings, as to what would really be the outcome of these cuttings. Anyone who has done silvicultural work has exactly this same feeling, and I find that

men who have been actually engaged in practical silviculture are warmly in favor of sample plot work."

Any number of cases can be cited where it would be doubtful how to proceed in making cuttings. For example, what method of cutting and subsequent treatment, such as brush burning, would best accomplish the production of sugar pine or of lodgepole pine? In thinning a mixed growth of chestnut oak and hemlock, about forty years old, is the oak worth holding for further growth at the sacrifice of the hemlock underneath; is it desirable to remove all the oak and save the hemlock, or is it better to thin out the hemlock to benefit the chestnut oak? How should a stand be reproduced? Should hickories which are becoming suppressed ever be left standing in mixed hardwood stands? Should white oak be favored on certain classes of soil, and can it be reproduced naturally? Can white pine land in Massachusetts be reproduced to pine, and if so, how? How should chestnut polewoods be handled? Such questions as these can, as a rule, be answered only by guesswork at present, as our knowledge of species is too much confined to glittering generalities concerning their silvicultural characteristics. We must practice silviculture and watch the results before we can really know the best methods of cutting for particular stands. We have been gathering theoretical and general information from the actual practice of silviculture, and such information forms an incomplete basis for forest management. It is a sad fact that all our work in forestry so far has resulted in very few examples of good silviculture. What we need is, not some boiled down conclusions about silvics, although these are good up to a certain point, but specified knowledge of results of applied silviculture under different local forest conditions. Sample plot work consists in the practice of silviculture under a great variety of conditions with the opportunity of getting exact record of the results of the work.

II. Purposes of Permanent Sample Plots

The term permanent sample plot is applied to an experimental forest area to be observed periodically over an extended period of years. The area of an experimental plot may be any size from a square rod to fifty acres or more in extent. While more detailed observations and measurements can be made on a smaller area, there is no reason why a large tract of forest cut in a certain specified manner should not be made to serve the same general purpose.

The purpose of the permanent sample plot is primarily to derive accurate data on the results of applied silviculture; and secondarily, the collection of certain data useful and necessary in the science of silvics.

Applied silviculture is another name for conservative forest treatment, the special objects of which, are: (a) To secure the establishment of a new stand to take the place of the mature one removed, usually accomplished in this country by natural seeding of the mature trees; (b) Care and treatment of the stand after establishment until ripe for the ax.

The science of silvics forms the basis for applied silviculture. Any form of forest management not based on a thorough knowledge of the silvical needs of the stand and its component species, is not liable to bring any results better than simple lumbering which has no regard for the future stand. The science of silvics includes the methods of establishing the stand, subsequent tending, and the adaptability of the different species and mixtures to different sites. The science must, therefore, also include a comprehensive knowledge of the silvical characteristics of the different species, such as reproduction, tolerance, resistance to damaging factors, requirements as to site, etc.

It is only by establishing sample plots in particular stands which can be under observation during many years, that

thoroughly reliable data can be obtained on the results of applied silviculture.

It will be possible to procure tentative silvical data at once from permanent sample plots, and thereafter, as the plots are again measured and observed, these data can be verified or changed and additional data obtained.

Sample plot work should be a line of scientific investigation aiming at accurate data along the lines of immediate practical use in forest management. Hence it is logical that such work be directed by the office which deals with the problems of management, as is at present the case. It is impossible to have proper forest management without reliable silvicultural knowledge, but this must be of such a nature, and turned over to the Office of Management in such shape as to be entirely practicable for use. All the technical silvical data should be based on thorough scientific work, or they are liable to prove worse than useless and may even be misleading. Much of the material already gathered is based on insufficient observation, and there are a great many direct contradictions among different authors.

The remedy for such a state of affairs is to be found in the establishment of sample areas for repeated observation and measurement. This will be the best method of verifying and correcting the silvicultural data at present on hand, as well as the best method of procuring additional accurate data.

III. Sample Plot Work in the East

Sample plot work, so far, has been confined almost entirely to private lands in the East, and chiefly to white and loblolly pine, red spruce and chestnut. Field work was carried on for six months during the years 1904 and 1905, by a party averaging three men. In 1906, nine months were spent in the field, and four times as much work was accomplished as in the previous two years combined,

due to increased system in carrying out the details of the work. There have been established in the East, 516 plots divided as follows: 283 large plots with a total area of seventy-nine acres, and with an average size of over one-fourth acre; and 233 reproduction plots, mostly one square rod in area. For the four species mentioned above, probably a sufficient number of plots for the present have been established. The benefits to be derived from this work may be summarized as follows:

(a) Based on data secured from these plots, it will be possible for the Forest Service, in the course of time, to issue publications showing the exact effect of given lines of treatment as applied to particular stands. This is what the private owner wants — figures on actual results of certain forms of forest management for specific kinds of stands. (b) These plots should also prove of great help to private owners as "demonstration forestry plots," where any one who wishes can see for himself the different methods of treating different stands, and compare the stands treated with similar ones left intact. As demonstration plots, they could be made to take the place, to a great extent, of woodlot and timber tract examinations, and in many respects would prove more satisfactory, since the forest owners could then see for themselves what certain stands look like after treatment in comparison with the untreated stands. It would be useful to establish plots in several localities in each State, so as to include stands typical of all the different forest conditions. Such plots and their records should always be open to examination by interested forest owners. (c) The plots will afford yield table data for regular stands, which will be valuable to the private owner in showing him what stands of certain species are capable of producing when sufficiently well stocked. (d) Silvicultural data for the Forest Service silvical files will also be obtained.

It goes without saying that the plots already established

by the Forest Service in the East should be kept up and periodically remeasured so as to derive the full benefit from them. However, it will probably be expedient to have any additional sample plot work in the East carried on, for the most part, as co-operative work with the different States.

In this case the Forest Service could direct and supervise the work, while most of the expense should be borne by the particular State where the work is being done. The State Forester should know what the important problems are in his particular State which need investigation, while the Forest Service sample plot corps would know the best methods to pursue in investigating those problems.

IV. Sample Plot Work for the National Forests

Although the Service has only made a beginning of sample plot work in the East and has taken up a very limited number of problems, the work done should prove helpful in studying silvicultural problems on the Forests. However, it will probably not be advisable to practice the detailed methods of sample plot investigation on the Forests for some time to come.

In regard to the Forests, I think all will agree that we must, sooner or later, try other methods of cutting than those now in use. The conditions out there are rough, and the first cuttings are necessarily made without much study. Wherever it is likely that other methods must eventually be used, there ought to be trial cuttings made over some specified area, say from ten to fifty acres. In some cases, all that may be necessary is to make a careful compartment description of the area cut over, with more details than are ordinarily given in such descriptions, and then come back from time to time and see what has happened. This is largely the nature of sample plot

work as at present best suited for the Forests, and it can often be done by the technical assistants. In some cases it may be feasible to introduce reproduction plots and methods of study such as have been used in the East. In the course of time the demand for more exact work will come. Wherever the technical assistant feels that more exact observations and measurements are necessary he can put in a requisition for such work.

Wherever possible, compartment descriptions should also be made for certain definite portions of the forest on cuttings which have been made and are being made on the Forests. Through such descriptions it will be possible to keep tab on the results of the different methods of cutting used. All methods at present employed are based on incomplete silvical data of the different species and stands, and it is important that the effects of the different lines of treatment be accurately observed and recorded.

These compartment descriptions also should always afford a source of reliable silvical information.

V. Important Lines of Investigation

The lines of investigation in important sample plot work should include the following subjects:

(1) Growth and yield of stands.
(2) Natural reproduction.
(3) Sprout reproduction.
(4) Artificial reproduction.
(5) Effects of thinnings.
(6) Effects of fires.
(7) Effects of grazing.
(8) Growth of trees left after partial clearances, as in lumbering.

In investigating the above subjects, a great variety of silvical facts, such as the soil and moisture requirements, and the tolerance or light requirement at different ages and

on different situations, will be obtained at the same time. The subject of natural reproduction is the most important one on the list, and includes a great variety of questions which should be investigated for different species. There is the general question of reproduction of the different species under different methods of cutting, and a number of more specific questions. The particular questions are concerned with seed production and dissemination; germination and seedling establishment, including study of suitable seedbed; development of seedling and sapling stands of varying densities of stock; seedling tolerance, and treatment of seedling stand after it is established.

It is now proposed to give, by way of example of methods employed in sample plot work, the details of establishing experiments to show the effects of thinnings. This is the most expensive and detailed line of work undertaken by the sample plot method.

VI. Details of Establishing Experiments to Show the Effects of Thinning

Experiments to show the effect of thinning upon stands of some of the important commercial species have formed, and should continue to form, an important part of sample plot work on private lands in the East. On the National Forests, of course, such experiments have little or no place at present, as the all-absorbing problems for sample plot work there should be reproduction and effects of fire and grazing upon it. But in the East, wherever improvement cuttings pay, it is desirable to have figures on the results to be expected from this form of forest treatment.

The method of experimenting with thinnings in regular stands is distinctly different from that used in irregular stands. It is proposed to give below the details of thinning experiments in regular stands. It is useless to try to get general results on the effect of thinnings in irregular

stands. Where the stand is irregular, it is advisable to determine only the effect of thinning around certain individual trees, or thinning in a small group under a certain very distinct set of conditions. For this purpose, single-tree or single-group plots are established which serve to bring out separately the effect of improvement thinning on distinct sets of conditions which together go to make up the irregular stand. It is not possible to obtain from such plots the yield per acre from thinning irregular stands.

Experiments in thinnings in regular stands aim to determine: (1) The effect of different degrees of thinning on the growth of the stand. This is for stands of particular species, and at different ages. (2) Yield from such thinnings. From these experiments it can be determined at what age and how heavily it is best to thin regular stands of certain species, what product the thinnings will yield, and under what conditions it is a profitable proposition.

The regular stands chosen for thinning plots are either practically pure, even-aged, well-stocked stands of a single species, or mixed hardwood sprout stands also regular as to age and stock. The stand must be comparatively immature, that is, still in the pole or small pole stage. These plots will, in all cases, furnish data for growth and yield tables in addition to that on the effect of thinnings.

The different steps in laying out plots for studying thinning and growth and yield in regular stands may be summarized as follows:

Location and survey.

Setting posts and marking trees to be cut.

Calipering and painting.

Cutting marked trees and taking heights.

Description, checking up of work, and measurements for sketch map.

There must be at least two plots with entirely similar stands in order to be of use in an experiment in thinning.

One of these is thinned while the other is allowed to stand for comparison. There are often three similar plots established, in which case two kinds of thinnings are carried out.

A great deal of care should be taken in locating the plots in order to have them in entirely similar stands, and in stands which are sufficiently regular in age and in distribution and character of stock. It is often very difficult to get such similar stands sufficiently large. The plots established so far range from one-tenth to five-tenths of an acre in size, but except in the case of young and dense sapling or very small pole stands, two-tenths of an acre should be the minimum size. The older the stand the more important it is that the plots be larger, but it will not usually be essential or convenient that the size exceed five-tenths of an acre. The position and size of the plots are first roughly determined by pacing and then carefully surveyed, using a staff compass or an octagonal staff head and staff for sighting, and a 100-foot steel tape, surveyor's pins, and plumb-bob for chaining. Pains are taken to have length of lines check up exactly, which is a good rule to follow in all sample plot work where the most careful accuracy should be practised in every detail. The plots are usually square or rectangular in shape, and if possible are laid out side by side, parallel to each other. They should always be separated by an isolation strip one to four rods wide, according to the size of the trees. Substantial posts, four to six feet long, four inches or over in diameter are firmly set at each plot corner. The material used should be sufficiently durable to last at least five years, and, if procurable, ten or more.

The next step is marking the trees to be removed on the plot or plots to be thinned. Where only one plot is to be thinned, it is usually given a medium thinning, and where there are two to be treated, one is given a medium thinning and the other a heavy thinning. The question of

the trees to be removed in sample plot work can best be determined after the stand has been divided into tree classes. Each tree, as calipered, is assigned to one of four classes, designated *one*, *two*, *two prime*, and *three;* or dominant, codominant, intermediate, and suppressed. Trees of classes "one" and "two" belong to the upper forest cover; class "one," where decidedly dominant and with symmetrically-formed crowns, and class "two" where less decidedly dominant and with unevenly developed crowns. Trees of classes "two prime" and "three" are overtopped trees, more or less dominated by classes "one" and "two," and have fallen in growth below the upper forest cover. "Two prime" trees have fairly healthy crowns, *and receive some direct perpendicular sunlight* on the tops of their crowns. To class "three" belong the remaining trees of the stand — trees without direct perpendicular sunlight on their crowns, for they are completely overtopped. Dead trees are not classified. A medium thinning removes intermediate and suppressed trees, and sometimes a few codominant trees which are in bad condition. A heavy thinning removes suppressed, intermediate, and codominant trees, and often some first-class individuals, but the thinning should never be so severe as to make a lasting interruption of the crown cover. In all thinnings the following rules are observed: (a) Wherever, through the removal of dominant trees, large openings are formed, healthy, overtopped trees should be left for ground cover. (b) The condition and density of the stand should be especially considered in all markings for removal of healthy, dominant trees. (c) Badly diseased, dying, and dead trees should always be removed. (d) It should be remembered that the general purpose of thinnings is to procure an even distribution of the most desirable trees, and provide for them individually a suitable amount of growing space. The trees to be removed are marked with scratchers or blazed with a hatchet, and the thinning in-

cludes a narrow strip a rod or so wide, extending around the outside of the plot. Thinning this strip more or less affects the growth of trees inside the plot.

The next step is calipering and painting the trees, and recording their crown classification. The crew consists of one caliper man and a tally man. The caliper man takes two diameter measurements at breastbigh at right angles to each other, and makes a small chalk mark at each of the points in the two measurements where the beam of the caliper touches the tree. The diameters are measured and recorded to 5-100 of an inch. By requiring the measuring to be done to 1-100 of an inch, carefulness in taking each measurement is assured, and the chances for error are reduced. The caliper man, besides chalking the dots, chalks also a number on each tree, and these chalk marks are subsequently painted. The crown class and species of each tree is called off by the caliper man, and recorded by the tally man after inspecting the tree, preferably from the opposite side, and thus checking the judgment of the caliper man. On rough-barked trees, such as loblolly pine, it is necessary to scrape off a patch of the bark with drawing shaves before it is possible to paint the numbers. The trees marked to be removed are given a number on the tally sheet and their diameters recorded, but, of course, it is not necessary to paint them. After the calipering and painting is complete, the thinning is then made, and lengths are taken of several trees of each class which have been cut. A careful silvical description is then written for each experiment, including also the purposes for which the plots have been established, and the character of the operations carried out. The work is then checked up to see that no trees were left out, all the dots and figures painted, etc. Finally, measurements are taken for a sketch map to show relative location of the experiments with reference to some prominent landmark.

The time required for two men to establish an experiment in thinning consisting of two half-acre plots may be summarized as follows:

Location, surveys, posts, and marking thinnings	1½ days
Calipering and painting	2 "
Cutting, heights, description, checking up work, and measurements for sketch map	1½ "
Total	5 days

Estimating the salaries and expenses of two men (one forest assistant and one forest student) at $8 per day, the total cost of the experiment of one acre would be $40.

VII. Office Work

The office work at present carried out in connection with permanent sample plot records falls under four heads:

(a) Duplication of the records.

(b) Filing of the records.

(c) Index in the form of a card catalogue of data contained in the records, and what may be procured in the future from the experiments.

(d) Working up of the results.

(*a*) *Duplication of the Records.*— Ink duplicates are made of all records as soon as conveniently possible after taken. The one set of original pencil records is not sufficient, as it would become more or less illegible through much handling, which it would necessarily receive. The originals are kept in the vault where they would be safe even in case of fire. Duplicate sets of the records will prove of great use whenever measurements of the plots take place, when it will be necessary for one set of records to be taken out of the office into the field.

(*b*) *Filing of Records.*—The ink copies of the records are filed in the section of Silvics, and are open to investigation and use by members of the Forest Service. A full page vertical file capable of receiving a 9½ by 12-inch envelope is used. The record sheets are kept in large envelopes, and are arranged according to States and localities both in the filing case and in the vault. A separate envelope is used for each group of experiments. On the outside of each envelope is written: the species, locality, owner, date established and by whom, and the numbers of the experiments. Crown cover and other diagrams, which will not conveniently go in the envelopes, are placed unfolded in large and shallow filing drawers.

(*c*) *Card Catalogue of Data.*—An index in the form of a card catalogue is essential in order to show all the data which the records contain and which can be expected to be obtained in the future from the various experiments established. Although each plot is established to procure a certain particular line of data, yet almost always there will be additional data obtainable from it. The card catalogue aims to exhaust all the data obtainable from each experiment either now or in the future. Such a catalogue is desirable for several reasons:

(1) It shows exactly what data have been procured to date, and what can be derived in the near future from the experiments already established.

(2) It will be possible to tell much more readily what additional experiments it is most essential to establish.

(3) The data will be in a conveniently accessible shape for use by the Forest Service in general.

(4) It will insure the getting of all that is possible from each experiment established.

The card index is made for each species separately, the cards arranged in the general headings of—

"Growth and Yield."
"Natural Reproduction."
"Artificial Reproduction."
"Sprout Reproduction."
"Effects of Thinning."
"Effects of Fires."
"Effects of Grazing."
"Growth of Trees left after Partial Clearances" (as in lumbering).
"Light Requirements."
"Soil and Moisture Requirements."
"Miscellaneous" (such as effect of leaf litter removal and other damaging influences).

(*d*) *Working up of Results.*— It will usually take *five* or more years to procure the main results for which a sample plot is especially established, at the end of which time it is remeasured. It will be possible to work up these results in the form of definite figures showing the actual changes in the condition of a particular stand, to bring out the factors that the changes brought about, and the exact effects of a particular line of treatment to which a stand has been subjected.

However, the sample plot work can furnish many silvical facts on the different species investigated immediately, without waiting for remeasurement. These facts should be properly recorded and classified in the silvicultural file where they will at once be avalaible for use. Also useful figures can at once be worked up from many of the experiments, though it may require five years and many remeasurements before the main results are secured. Thus the reproduction plots of loblolly pine show, without remeasurement, how thickly it seeds up under certain conditions; the thinning plots show the amount of produce and value of material removed in thinning certain stands. It may be

possible to work up preliminary growth and yield tables based on the first measurements of plots already established in loblolly and white pine stands. The relative success of certain artificially reproduced stands, and number and vigor of sprouts from trees cut under different conditions, can likewise be ascertained from the first observations and measurements made when plots are established in those kinds of stands.

A NEW EXPLANATION OF THE TOLERANCE AND INTOLERANCE OF TREES

RAPHAEL ZON

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There are many fundamental silvicultural facts which are now explained by the so-called tolerance and intolerance of trees. When young growth becomes stunted or perishes beneath the shade of mother trees, this is invariably ascribed to the intolerance of the species — its inability to develop in the shade. When after heavy thinning the remaining trees show an increased growth, this again is at once explained by the greater access of light to the crowns of the trees. There exists even a special form of forest management based on what is called the light increment (*Lichtungszuwachs*). When reproduction fails to come up in a forest managed as a selection forest, the intolerance of the species is again brought to account for this. These observed facts are unquestionably true. Young growth does frequently perish under the shades of an old stand; trees after lumbering do often show an increased growth, and so on; but are these facts due to the direct influence of light alone? Are there not some other factors which could produce the same results? The foundation upon which the forester bases all his practical work in the woods is the relative dependence of tree species upon light. In accordance with this dependence upon light he divides all trees into two large classes: tolerant and intolerant, or shade-enduring and light-needing. This dependence of the tree species upon light had been first formulated by Pfeil and Gustav Heyer. Owing to the enormous authority which Pfeil enjoyed at this time in Germany, his opinion, based on superficial observations and never scientifically analyzed, had

soon become a dogma which traveled from one manual on silviculture to another, until now Pfeil's classification of trees into shade-enduring and light-needing is repeated in a thousand different ways, in almost every publication on forestry here and abroad.

Meanwhile there has been accumulating a great number of biological, ecological, and silvicultural facts which do not harmonize with the accepted division of all tree species into light-needing and shade-enduring. These facts tend to show that trees are not endowed with any inherent capacity of withstanding different degrees of light; they are not born tolerant or intolerant, but each tree under certain conditions is capable of growing thriftily in the open as well as when shaded from the side or even from above. The trees adapt themselves to different light conditions by assuming a form characteristic of open or shaded situations. What actually does exist and is observed are two distinct forms of trees: one corresponding to trees growing in full light, the other to trees growing in the shade, and any tree under certain conditions can assume either of these two forms.

Thus trees grown in the full enjoyment of light develop spreading, compact crowns and short internodes, their leaves are narrow and of small size and pointed upwards, having, as a rule, the upper and under surfaces alike; they are thick and their palisade tissue is strongly developed; their epidermis is thick, the leaves are shiny and hairy, especially on the under surface. The trees grown in the shade develop almost diametrically opposite characteristerics: they are usually tall and their internodes are elongated; their leaves are large, broad, and spread horizontally, and their upper and under surfaces are not alike; the leaves are thin, their palisade tissue is poorly developed or is entirely lacking, but instead the intercellular spaces greatly increase; the epidermis is thin, consisting only of

one layer of cells, and contains chlorophyl; the cuticle is thin, the leaves are only slightly tomentose and often even entirely glabrous.

Such are some of the anatomical features peculiar to trees grown in different degrees of light. The so-called tolerant species, like beech or sugar maple, when grown in the open are capable of assuming a light form, and intolerant species like white pine or oak, when grown in the shade are capable of assuming a shade form. It would be, however, too hasty to infer, from the fact that these structural differences are found in trees grown under different light conditions, that light alone is responsible for them. Thus it is a known fact that the palisade tissue becomes strongly developed in places with a very dry climate. It was also established by experiments that the thickness of the palisade tissue increases not only through greater access of light but also through increased transpiration and through other factors affecting the absorption of water from the soil by the roots (which, of course, also affects transpiration). Investigations have been made as regards four factors affecting transpiration — dryness of the soil, atmospheric dryness, abundance of soluble salts in the soil, and light. Attention has been chiefly directed to the leaves as being the chief organs of transpiration. All experiments have led to essentially similar results, namely, that whatever diminished the absorption of water from the soil, like an abundance of soluble salts in the soil, or accelerated the exit of water from the plant, like dryness of the air or intense light, occasioned the following deviations from normal structure: (1) Reduction of leaf surface; (2) Diminution of intercellular spaces containing air; (3) Augmentation of the vessels; (4) Lengthening of the palisade cells; (5) Increase of the thickness and amount of cutin of the outer wall of the epidermis; (6) Sinking of the stomata; (7) Increased number of air-containing hairs; (8) In-

creased number of water-storing cells. These modifications resist the danger of excessive loss of water, whether the danger arises from too little absorption or from excessive transpiration. By a reduction in the size of the leaf and of the intercellular spaces the transpiring surface becomes smaller (for a given mass of plant substance); the conduction of water is facilitated by the increase of the vessels; transpiration is reduced by a thicker cuticle, by the presence of air-containing felted or silky hairs, and by the sinking of the stomata; water cells have a similar action, and besides this they rapidly fill whenever the water supply is increased and yield their contents to the assimilating cells as the supply of water is reduced.[1] In other words, deficient moisture or increased transpiration produce the same structural modifications in the leaves as are found in trees growing in light, and the structural modifications which protect plants from the effect of dry air and wind, and help to check evaporation from the leaves, are identically the same that serve for the protection of the plant against a strong light. On the other hand, Sorauer, Mer, Vesque, Lothelier, and others have found that the effect of abundant atmospheric humidity is entirely analogous to the effect of deficient light. Plants in the presence of excessive air humidity become taller, thinner, and paler; the leaf blades develop poorly and are more transparent, the palisade tissue become thinner, or does not develop at all; the fibro-vascular bundles become less numerous, the intercellular spaces increase, etc. These changes are undoubtedly due to the change in the process of transpiration which takes place in a humid atmosphere.

From all these facts, one is justified in inferring that it is the differences in the conditions of transpiration that produce the structural differences found in trees grown in

[1] "Plant Geography Upon a Physiological Basis." A. F. W. Schimper, page 5.

the open and trees grown in the shade, and not light conditions alone, as was the accepted opinion heretofore. Light unquestionably plays a part in causing these structural differences, since all sun rays are at the same time heat rays, and heat increases transpiration; therefore, transpiration of plants is regulated by the degree of light. Temperature and moisture conditions, however, are of immeasurably greater significance in causing the structural characteristics peculiar to trees grown in shade and in light. Experiments with artificially changing the intensity of light without changing at the same time moisture and transpiration conditions failed to produce any clearly noticeable structural changes in the leaves; while by changing transpiration conditions alone at the same intensity of light, structural changes in the leaves have been successfully brought about. In the presence of abundant humidity or lowered transpiration, the structure of the leaf corresponded to that found in the shade and under reverse conditions to that grown in the open. Probably the three factors — moisture, temperature, and light — work together in influencing the structural adaptation of plants, and it is often difficult to determine with certainty what modification has been brought about, for instance, by the humidity of the air and what by the other two factors. The anatomical peculiarities of the shaded trees are hardly caused by the greater humidity of the air alone within a dense stand, since the decreased light must also exercise a perceptible effect; and likewise the pecularities of the trees growing in the open are produced, not by the strong light alone, but also by the high temperature in connection with the increased evaporation.

Besides these biological and ecological data there are also a number of silvicultural facts which the accepted theory of tolerance and intolerance of species cannot very consistently explain. It is a matter of common observation

that trees within the same climatic region when grown in fresh or moist soils are more tolerant of shade than when grown on dry or poor soils. There are many instances when reproduction of intolerant species, which, according to the prevailing conception of intolerant species, cannot exist when shaded, especially from above, persists for a long time under the cover of mother trees, and when liberated fully recovers. Virgin forests of such intolerant species as longleaf pine, for instance, reproduced themselves naturally for centuries before man even thought of any forest management, and any cross section of longleaf pine that had grown up in a virgin forest will show by its narrow rings in the center the long period of suppression which it withstood in its early life.

It is interesting to note that the discussion concerning the best method of reproducing Scotch pine in Germany played a great part in destroying the illusion of the infallibility of Pfeil's classification of tree species into light-needing and shade-enduring. Borggreve was one of the first to raise his voice against the too far-fetched teaching concerning the dependence of trees upon light. At that time the practice of clear cutting Scotch pine, which was believed to be dictated by its inherent demand for a great amount of light, began to show bad effects; therefore the possibility of successfully raising the intolerant Scotch pine under shelter wood advocated by Borggreve found many followers. In Russia, Professor Morozov struck another blow to the theory of intolerance of trees by proving beyond any shadow of doubt that the failure of Scotch pine to come up under the shade of mother trees on dry, sandy soils was due, not to lack of light, but to lack of moisture in the soil. But the hardest blow to the cult of light as the prime cause of nearly all phenomena observed in the forest was struck by Fricke, who carried on for a number of years a series of most successful and convincing experiments. These ex-

periments, if they do not discredit entirely the accepted theory of tolerance and intolerance of species, make necessary, at least, a thorough revision of all its premises.[1]

His first series of experiments were made in a pine stand grown on the poorest, dry, sandy soil on which, according to the opinion of all authorities, the light requirements are the greatest. In a pine stand from seventy to one hundred years old with a crown density of 0.7 were located isolated groups of suppressed young pines, among which there were no old trees. The young pines were ten years old and a little over a foot and a half in height. These groups were surrounded by ditches ten inches deep; in this way all the roots extending from neighboring old trees were cut through to a depth of ten inches. The amount of light received by these groups of undergrowth remained the same throughout the whole time of the experiment, since not a single tree has been cut down. The ditches were made in the spring. In the first summer the needles that appeared on the little pines within the isolated groups had doubled the length of the preceding summer, the terminal shoots became longer, and this thrifty growth continues up to the present day, while the same undergrowth outside the areas surrounded by the ditches preserved the same suppressed character. The old trees, whose superficial roots were cut through, apparently did not suffer and none of them were uprooted by the wind. On the areas inside the ditches there sprung up during the first summer a rich flora. Entirely unexpected, there appeared bell flower (*Campanula*), wild strawberry (*Fragaria*), hawkweed (*Hieracium*), sorrel (*Rumex*), ironweed (*Veronica*), willow herb (*Epilobium*), star thistle (*Centaurea*), geranium (*Geranium*), violet (*Viola*), five-finger (*Potentilla*), and other herbaceous plants, and in addition there sprung up a number of seedlings of birch and sor-

[1] *Centralblatt für das Gesamte Forstwesen.* 1904.

bus; but what is most interesting, none of these species occurred in the neighboring stand. The herbaceous vegetation which was present on the ground before the experiment -- sweet vernal grass (*Anthoxanthum*), hairgrass (*Aira*), bentgrass (*Agrostis*), woodrush (*Luaula*), etc., and led a very precarious existence, had luxuriously developed so that the areas surrounded by the ditches appeared at a distance like green, succulent vegetation and presented a most striking contrast to the grayish-brown ground cover of the rest of the stand.

In another old pine stand one hundred years old, growing on poor soil, there were laid off several natural openings of two to five square rods on which there were no old trees or reproduction of any kind. These open areas were again surrounded by ditches and sowed with seeds of Scotch pine, spruce, beech, and red oak, without any preparation of the ground. Similar sowings were made on similar natural openings not surrounded by ditches. On the area inside the ditches there may be seen now remarkably well developed seedlings of pine and oak, but with characteristics peculiar to shaded plants, and also seedlings of beech and spruce, whereas at a distance of some seven or ten feet on the other side of the ditches, although a part of the seeds did come up, the seedlings of pine, beech, and spruce were from the start of very poor development and soon died; the seedlings of oak which still persist have scarcely reached one-fifth the height attained by their more fortunate comrades inside the ditches, and will hardly last very long. In this stand on the openings surrounded by the ditches there also appeared a luxuriant herbaceous vegetation strikingly different from the herbaceous vegetation of the surrounding forest.

The results of these experiments clearly show that the unsatisfactory condition of an undergrowth shaded laterally or from above is not due to insufficient light but to

the competition of the roots of the neighboring old trees. Likewise the competition of the flora of the shrubs, grasses, and mosses in our forest depends very little upon the amount of light, but is chiefly conditioned by the degree of dessication of the soil by the roots of the old trees.

For the same reason, the well-known fact that reproduction directly under or near the seed trees, as a rule, develops poorly must be explained, not by shading, not by the mechanical action of the water dripping from the leaves and branches of the old trees, not by the excessively strong light produced by the reflection of light from the trunks, but by the competition of the roots of the seed or nurse trees which dry out the soil to such an extent that the young seedlings cannot satisfactorily develop on account of deficient moisture in the soil.

On fresh soils with an abundant supply of moisture such competition does not affect the growth of the seedlings, or if it does affect it, it is less noticeable, and for this reason it is assumed that trees are more tolerant on fresh or moist soils than on dry soils. But even on the same kind of soil the effect of trees of different species upon the growth of seedling is not the same. Trees with a strongly developed superficial root system that extends in all directions naturally dessicate the upper layers of the soil much more than trees with a compact, deep root system.

In filling out fail places in old plantations, the competition of the roots determines the success of the operation. It happens only too often that planting the fail places on dry or only moderately fresh soils meets with an entire failure. When additional seedlings are planted among young trees which have already fairly developed since the first planting, the growth of the new seedlings is often made entirely impossible on account of the dryness of the soil produced by the roots of the older seedlings which in the porous soils of the planting holes attain, as a rule, an extra

good development. Therefore, if it is desired to secure a dense stand on dry situations, and if the first planting left fail places, the additional planting must take place not later than three years after the first one, otherwise it will be necessary to give up entirely the filling up of the blank places, or the planting will have to be done by small areas from which all older competitors have been removed.

In an entirely new light appears now also the question as to the causes of the so-called "light increment." It is true, however, that even before Fricke published his work there were heard voices against the former narrow opinion that the increase in growth of trees remaining after logging or thinning is entirely due to the greater access of light. The explanation which was given, for instance, by the soil physicist Ramman is in perfect accord with Fricke's deductions. He showed that by thinning a stand not only the light conditions alone are changed, but that the competitoin of the roots is also diminished, which leads to an increase of moisture in the soil. At the same time the leaf litter, owing to the greater amount of light, is more readily decomposed and the soil in this way becomes enriched with nutritive substances — all this together results, of course, in an acceleration of growth after thinning.

In order to prove that it is nothing but the deficient moisture in the soil brought about by the competition of the roots that causes the death of pine reproduction under the shelter of mother trees, Fricke established another series of experiments which yielded most convincing results. During the summer months of 1902 Fricke determined the moisture of the soil in a 100-year old pine stand of an average height of from fifty-eight to sixty-five feet, crown density 0.7, growing on a poor diluvial sand. The samples were taken at a depth of one, six, and twelve inches from the surface of the mineral soil. Two samples were taken in each case and from three different places.

(1) In an opening of about ten feet wide and surrounded by a ditch ten inches deep; (2) In an opening of about sixty-five feet wide within the forest and not surrounded by a ditch and consequently the ground penetrated by living roots of adjoining old trees; and, (3) In the stand itself, not surrounded by a ditch, and the ground consequently penetrated by living roots. The amount of precipitation that fell during the experiment was normal for the given locality. The soil samples were dried for forty-eight hours at a temperature of from 80 to 100 degrees centigrade and the moisture contents were expressed in per cent of the volume. The results are given in the following table:

Sample taken	*Depth*	*Opening surrounded by a ditch; soil* not *penetrated by roots*		*Opening not surrounded by a ditch; soil penetrated by roots*		*Adjoining forest; soil penetrated by roots*	
1902		1	2	1	2	1	2
	Inches	*Per cent*		*Per cent*		*Per cent*	
	1	14.4	13.5	8.9	10.1	10.8	8.3
June 28.....	6	10.4	10.1	5.8	7.4	6.4	5.4
	12	8.1	8.4	4.7	6.2	5.2	4.6
	1	14.6	13.1	12.2	11.7	12.5	12.8
July 15.....	6	9.2	9.8	8.5	7.6	8.2	7.7
	12	6.3	6.2	6.3	4.9	6.1	5.7
	1	12.2	11.5	9.0	8.2	10.4	5.6
August 15....	6	7.4	7.8	6.2	5.5	6.8	4.6
	12	6.0	6.0	5.1	4.2	5.8	4.4
	1	12.8	15.0	7.7	8.0	8.3	6.4
September 4.	6	8.4	8.7	4.1	3.8	3.4	4.6
	12	5.8	6.7	3.5	3.0	3.3	3.3

This table shows clearly the extent to which the roots of trees dry the soil and how the moisture contents of the upper layers of the soil can be perceptibly increased after the roots have been cut through.

Similar results were obtained by the following investigations made in a dense stand of saplings of excellent growth on good soil. An iron cylinder covered with a coat of zinc to prevent rusting, having a diameter of sixteen inches and a similar length, was driven into the ground to such a depth that its upper end was on the same level with the surface of the mineral soil (just beneath the leaf litter). The lower end of the cylinder was made of steel and had a very sharp edge in order to be able to cut readily and smoothly through the leaf litter and the roots. The soil within the cylinder fully preserved, therefore, its original structure and differed from the rest of the soil in the forest only by the absence of living roots in it. The cylinder was driven into the ground at a place where the crown density was considered to be the average for the whole stand. The cylinder remained in the ground for two years. In June, 1904, the moisture contents of the soil was determined inside of the cylinder and outside of it. The following figures were obtained for the moisture contents of the soil in per cent of the volume (just as before):

Sample taken	*Beneath the leaf litter*	*At a depth of* 4″	8″	12″	16″
	%	%	%	%	%
Within the cylinder....	15.2	13.8	11.0	8.8	7.2
Outside the cyiinder...	13.8	4.5	4.8	3.9	3.4

In 1901 an exactly similar iron cylinder was driven into the ground in the same manner in an old pine stand, but this time the cylinder was covered by well-fitted lid and the crack between the lid and the edge carefully filled (puttied) so that no water could enter the cylinder from above. At a distance of about three and a half feet from the place where the cylinder was driven into the ground an

iron sheet was placed on the ground with the edges bent downward for about two inches and driven into the ground so as to make the sheet lie tight to the leaf litter. The purpose of both contrivances was to prevent atmospheric moisture from entering the soil from above in the places covered by the cylinder and the iron sheet, while the spreading of the water downward could in either case go on without any hindrance. There was only this difference between the soil contained in the cylinder and under the iron sheet: the soil under the iron sheet contained living roots, while in the cylinder all the roots were cut through. In March, 1902, i. e., a year later, the soil was investigated and the following results were obtained for the moisture contents of the soil under the iron sheet and from the cylinder:

Sample taken	*At a depth of* 2″	8″	14″	16″
	%	%	%	%
From beneath the iron sheet...	6.7	4.0	3.8	2.5
From within the cylinder	11.7	9.8	8.1	7.1

In 1901, in a pine stand fifty years old, a hole was made in the ground eighteen inchees deep, and at the bottom there was placed an iron sheet similar to that used in the preceding experiment, but with edges this time bent upwards. The soil which was taken out from the hole was placed back, great care being exercised to preserve the same natural arrangement of its different layers including that of the leaf litter. Near the place where the iron sheet was buried the following manipulation had been performed: A hollow cylinder similar to those used in the other experiments was driven into the ground and then taken out together with the soil that filled it. The bottom of the cylinder then was carefully closed with a well-fitted cover and

the whole cylinder, together with the soil in it, was put back in the same place from which it was taken out. By such arrangement the conditions of the last experiment were entirely reversed. Now the access of atmospheric precipitation to the soil from above remained free, but the sinking of the water into the deeper layers of the ground in places occupied by the iron sheet and by the cylinder was prevented. In the soil *above* the iron sheet the rootlets of the trees branched out and developed even more than before, because of the breaking up of the soil; in the cylinder, of course, there were no living roots. In 1904, consequently three years after the experiment began, the moisture contents of the soil were determined. The results are given in the following table:

Sample taken	*At a depth of* 4″	8″	12″	16″	18″
	%	%	%	%	%
From above the iron sheet..	6.7	4.6	5.5	4.8	4.5
From the cylinder.....	18.4	18.2	26.3	36.7	
From the forest.....	4.5	4.8	4.6	4.3	4.7

That the insignificant moisture contents of the soil just above the iron sheet, especially striking when compared to the moisture contents of the soil inside the cylinder, is exclusively due to numerous rootlets of the pines penetrating the soil has been clearly demonstrated by another experiment. In 1902 an exactly similar iron sheet with the edges turned upwards was in a similar manner buried in a hole eighteen inches deep made on an area covered with a two-year plantation; the ground consequently was free of roots of large trees. The moisture contents of the soil was determined one year later. The results are shown in Table V:

Sample taken	*At a depth of* 2″	8″	14″	17″	18.4″	28″
	%	%	%	%	%	%
From above and beneath the iron sheet.....	14.2	15.2	21.3	*24.8*	8.7	5.8
From a place near the iron sheet.....	14.6	10.7	8.6	*6.9*	6.9	7.6

As can be seen from these figures the moisture contents of the soil just above the iron sheet free of living roots was 24.8 per cent, while in the former experiment, when the roots were present, the moisture contents of the soil just above the iron sheet was only 4.8 per cent.

All these investigations bring out, it seems to me, in a most convincing manner, the tremendously decisive influence which the water-absorbing activity of the living roots has upon the moisture contents of the soil. These experiments have also proved unmistakably that in a dense as well as in an open stand the humidity of the upper layer of the soil increases very perceptibly when the superficially spreading roots are cut through. They also have proved that reproduction springs up in a forest in places where there was none at first, as soon as the roots of the adjoining trees are cut through, although the crown density is not interfered with in the least. Putting all these facts together, there follows, as a logical necessity, the deduction that failures of natural reproduction or suppression and even death of reproduction that had come up under the cover of old trees on poor, dry soils is not due in the least to lack of light but to the competition with the roots of mother trees, and to the resultant dryness of the upper layer of the soil.

It may be interesting to mention in this connection that experiments conducted by Visozky, Morozov, Wollny, and Ebermayer, for an entirely different purpose, namely, to determine the effect of forest cover upon stream flow, have also

demonstrated most conclusively the greater dryness of the soil penetrated by the living roots of trees, and Otozky and Henry have proved, independently of each other, by actual measurements the water level to be lower under forest cover than under any other plant growth. Some of Professor Henry's conclusions are as follows:

(1) The water level is never higher under a forest cover than under bare soil.

(2) The surface of the ground water is always found to be further removed from the surface of the ground under forest than outside of the forest or under a cut-over forest; this being true for both winter and summer.

(3) The water level is lower in old forests than under young stands.

In closing, I would suggest that we think for a moment of a tree as consisting of a long pole which at both ends dissolves itself into a mass of branches or crowns of which one is buried in the ground and the other is above the ground, and that the one above the ground has practically an unlimited space to grow into, an unlimited supply of nourishment and all the sun energy necessary for the decomposition and assimilation of the carbon of the air; while the one under the ground, except in wet soils, has a limited supply of water indispensable to all the physiological functions of the tree, and is often hampered in its growth by the proximity of the underlying rock. Must we not admit, then, that in searching for causes of the many phenomena observed in the woods, we have altogether "looked *up*" too much and "looked *down*" too little?

FOREST FIRE INSURANCE IN GERMANY

SAMUEL J. RECORD

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Fire is undoubtedly the greatest menace to conservative forest management. In better established businesses, immunity from loss may be secured by the payment of a given premium to an insurance company. The American timber owner, however, must assume his own risk, and the sum involved in attempted protection and losses makes the rate exorbitant.

Such a condition, however, will not be permanent. With a sufficient decrease in our forest resources, together with an increase in population and local demand for timber, more intensive forest management will result. Exploitation will give place to conservative management, and forest fires will gradually decrease in extent and importance. The situation will then present many phases similar to conditions in European countries. For this reason it is interesting and instructive to note their methods and use their results as object lessons.

For a number of years, some of the more important fire insurance companies in Europe have included forest properties among their risks. The most notable of these is the Gladbach Fire Insurance Company, of Munich, which set apart a special forest fire department in 1895. The progress at first was rather slow, but has now passed the experimental stage and become well established. At the close of the year 1903 their outstanding insurance covered a total of 333,175 acres, of which considerably more than half was pure pine forests. During eight years, 4,787 acres were burned over, for which a total indemnity of $106,000 was paid. As shown by their forest fire statistics, the dan-

ger from fire is constantly increasing, owing largely to the extension of railroad systems, and also to the increase in the planting of pure pine forests in waste places and the consequent decrease in the area of broadleaf and mixed forests.

In the making of a rate, a distinction is made between propositions which pertain to large, varied, complex forests, with age classes ranging from one to sixty years (or those under similar conditions which have higher age classes), and those which pertain to areas of young growth only. For the first division which includes most of the well-managed forests, the premium varies from a maximum of $4, to a minimum of $0.45 per thousand dollars of the sum insured, which may be increased on account of unusual fire danger. Those which are assessed at the maximum rate are naturally those which are exposed to the greatest danger from fire and complete destruction. Young conifers would be the highest, while the rate for the older stands will vary according to the species and age. As to the second division, which includes mostly forest plantations and protection forests, the above schedule of premiums does not hold true. For this class fixed rates are not made, inasmuch as each requires special consideration; therefore, it is not uncommon for the premiums to exceed somewhat $4 per thousand.

In setting a fixed limit to the premium, questions more or less technical in character have to be taken into consideration, the solution of which can only be approximated. From the standpoint of the forester the following must be taken into account, viz.; species, form of management, relation of the different age classes, condition of the forest floor, presence of compartment lines, etc. From the standpoint of technical insurance, railroads, industrial establishments, collieries, proximity of the forest to large villages, and the presence of places of amusement, such as dance halls and taverns, are to be considered.

In order to afford the applicant the opportunity of ascertaining the rate or premium before a definite contract is made, and in order to determine whether he wishes to give final consent to the insurance, a so-called provisional agreement is made which does not bind the applicant to anything, and is furnished free at any time he may desire it.

In the application, the printed questions must be answered in full, and the stand described according to method of management, area, age, species, and the value, as well as the position according to locality and landmarks. The forest map (in larger concerns, a copy of the stand map or of the land register map; in smaller cases, a simple sketch map is sufficient) must be made in such a way as to show the relative position to each other of the tracts to be insured, as well as the division of the areas into types and age classes.

As a result of these steps, a premium rate is formulated. If this is accepted by the applicant, the making of the policy is begun. The valuation of the stand is one of the most important questions in the making of a contract. In the case of heavy risks, the opinion of an expert appraiser is always recommended as a basis of this valuation. For young timber the valuation can be made by the owner himself from tables of cost furnished by the company.

Only forests which possess a definite form of management, and in which a sustained yield takes place, are eligible for insurance, and then only for periods of not less than ten years. In order that the owners of small forests may be protected in the highest degree, the increment is insured. This is done by letting the sum for which it is insured increase yearly at a certain per cent of the original valuation. The per cent of increase to be made is to be specified by the applicant, and depends upon the method of management, age, species, and quality of locality and stand. The greatest growth per cent is in spruce stands

growing on good soil; the lowest, in forests of rocky situations where the decrease in value as a result of their distance to market may be taken for granted.

If the value of the stand has been determined in a correct manner, the business conduct will go on smoothly, and no false hopes nor differences in adjustment will arise. Over-insuring is in no case desirable, for it has only one result: causing the insured useless expenditure for premiums, since in case of eventual damage by fire, only damage based upon the true value of the stand will be paid, and grounds for misunderstanding will easily result if this indemnity be of smaller sum than that which the insured expected under the over-insurance. The company desires to avoid all such controversies and to have all insurance so arranged that small damages can be settled, according to the terms of the policy, by correspondence.

The regulation of damages is a much broader question. By way of introduction, the company makes all calculations of forest valuation on the customary three per cent compound interest. The method of calculation varies according to the age of the stand damaged by fire. Then comes the question of the valuation according to —

(1) The cost of the stand;

(2) The expectation value of the stand;

(3) The market value of the stand.

Just where the boundary lies up to which one and after which another of these conditions exists, cannot be generally stated. Much depends upon the concrete case, and above all things the period of rotation plays a very important and decided role in the determination of this question. In general, it can be assumed that the calculation according to the cost value has to do with a time long enough for the first thinning of the stand to be made, which in a low rotation can fall in the middle of the period of rotation. The valuation according to the sale value ap-

plies to such stands as are clear cut in the course of ten-year working periods. Between the two limits, the period in the life of the stand is practically fixed, in which the valuation according to the expectation value is employed.

(1) *The calculation of the valuation according to the cost value of the stand.*

The cost value is composed of: (a) the cultural expenses (including replanting); (b) the possible soil rental; (c) the management and protection expenses, taxes, etc., all calculated with compound interest from the first year of the stand's age. To be deducted from this are the eventual proceeds from the thinnings and the intermediate yields according to their proper future value, as well as the value of the present burnt timber whenever the value thereof exceeds the expense of removal. The difference between the two sums gives the real damage to be recovered, if not in excess of the face of the policy. However, in dealing with only partially closed stands a reduction of the indemnity is made according to the density in tenths.

(2) *Calculation according to the forest expectation value.*

The forest expectation value is the present net value of all future returns expected from the forest capital. It is determined by discounting to the present time, at compound interest, all returns and expenses anticipated. From this result, must be deducted the value of the damaged timber. The remainder represents the actual damage. Whether this amount can be fully or only partially recovered, depends upon the relation which the face value of the policy bears to the calculated expectation value.

(3) *Valuation on the basis of the sale value of the stand.*

The sale value of the stand is that which it actually affords in practice. The method of calculation is as follows: The volume of the stand is found and classified according

to valuation surveys of the area. The volume of a certain class is multiplied by the current market price, the result being the sale value of the stand. However, since a sale following a fire is forced, the time for it is apt to be unfavorable, and the more the timber is injured by fire the less the sale will bring in comparison with opportune sales of sound material of like quality and species. It is therefore important to note that a decrease in value is occasioned by fire. It would, of course, be simplest to await the results of the actual sale, since there is no exact relation to the normal sales of the same year. This is done, however, only in rare cases and only at the request of the insured party, since a well-regulated and exact method of business demands the quickest possible settlement after the occurence of a fire.

The damages paid are supposed to cover the depreciation in the selling price of the timber due to the fire. The company sends an expert who inspects the stand and appraises the damage. His report is used as a basis for an offer to the insured party. If dissatisfied, the latter may also choose an expert and these two, before beginning the appraisment, select a third to serve as an umpire to decide only such points as have been left in dispute, keeping always within the limits of the appraisements of the two original experts. The verdict, certified in writing, must state: (a) The total value, prior to the fire, of the timber on the burned-over tracts; and (b) The total value of the same after the fire. These proceedings possess obligatory power for both parties and are conducted at joint expense.

A common method of determining the value of the burnt timber is to call for bids from various wood dealers. Sometimes the company makes a special agreement and assumes the obligation of reforesting a damaged tract at its own expense.

All policies contain a clause which exempts the company

from liability for such damages as arise during a war from military steps taken by a commander, or are the sequel of a riot, a disturbance of the public peace, or an earthquake.

The insured party must not cause or permit an increase of the fire risk, take out other insurance on the tract, or allow the insured timber to change ownership until a written agreement to these changes has been secured from the company.

After a fire, the insured party is required to give notice of it to the agent within twenty-four hours, and to the local police office within three days. He must also do his best to quench the fire and protect the timber. After a fire, he must leave the premises intact until the amount of the damage has been established.

In no instance is the insurance to be the means of a profit; its only purpose being to make restitution for the damage to the insured timber in conformity with its real value in the forest at the time of the fire. The insurance in itself furnishes no proof of the existence and value of the insured objects at the time of the fire. The face of the policy, however, forms the limit of the responsibility of the company. If the insured timber has a lower value than the face of the policy, a reduction of the indemnity will be made in proportion. The company claims the right of investigating the value of the timber, as well as the cause and extent of the damage, and of requiring of the insured such affidavits and other proofs as may be needed to substantiate his statements and claims.

If the insured has caused the conflagration either willfully or by gross negligence, or has failed to give timely notice of it to the agent, or if there be sufficient evidence of fraud or concealment at the investigation of the damage, he forfeits all claim to indemnity.

After a fire, the amount of the insurance is reduced by the sum of the indemnity. After every damage, either

party possesses the right to cancel the insurance by written notice at the end of two weeks after receiving the information.

Certain precautions must be exercised in conducting work in the insured woods. The building of fires is absolutely prohibited during continuous dry weather or high winds, though otherwise they may be lighted, but only on vacant lots and at a distance of not less than ten feet from underbrush, heath or other inflammable material. Fires so kindled must never be left unguarded.

If standing timber be sold, the insurance on it ceases the day the property is transferred to the purchaser, though the remaining part of the insurance is not thereby affected; the purchaser, however, may make this timber, whether standing or cut, the subject of a separate insurance by the company.

Piles of wood or logs must be set up at a distance of not less than four rods from buildings with fire-places of any kind. If steam engines are used in handling or working up the felled timber, a separate agreement must be made regarding the precautionary measures required in such case.

In order to inform the public that the woods are insured, the company furnishes insurance signs (for a consideration) which are to be tacked up conspicuously, especially along the insured timber tracts or along the roads passing through them. Should damages or offences against the insurance contract occur against the will of or without the knowledge of the insured, he is not to be held responsible.

Such, in general, are the more important considerations in the insurance of timberlands in Germany. While the time may seem remote, it will surely come when American fire insurance companies also will add forest properties to their risks.

A ROUGH SYSTEM OF MANAGEMENT FOR FOREST LANDS IN THE WESTERN SIERRAS

W. B. GREELEY

Delivered before the Society April 18, 1907

This paper deals with the forest of sugar and yellow pine, white fir, and incense cedar, which lies on the west slope of the Sierra Nevadas from the southern end of the range at Mt. Breckenridge northward to the American River. Without attempting a detailed description of this well-known timber belt, I will touch upon a few of its salient features from the standpoint of administration.

In the first place, we are dealing with a region which, industrially, is young. The early mining in the Sierras was in the main short-lived, and only in comparatively few localities contributed to the permanent up-building of the section. The use of the mountains as summer range by sheep and cattle from the valleys for some thirty or forty years has left no permanent mark, except an uncertain trail here and there or a road of dubious value. The Sierras have waited until the growing population and expanding industries of the central and coastal valleys of California created a stable demand for their two great resources, namely: water power and timber. And this has taken place only within the last ten or fifteen years.

Inaccessibility has also been an important factor in the slow opening of the west Sierra Forest. It stands from 4,000 to 7,000 feet above and from thirty-five to seventy miles distant from railroad shipping points. It lies on the heads of the lower drainage and along the series of secondary ridges which jut out westward from the backbone of the range, cut off from market by a long stretch of rough

cañons and broken foothills. The problem of transportation has been successfully met only by an enormous outlay of capital such as no operation, except on a large scale, would justify. The principal plants now operating in this region have expended in each case not less than $300,000 for roads, flumes and logging railways — an expense representing one-half, at least, of the total investment. Lumbering operations of this magnitude, of necessity, have waited for large orders and strong markets in California and the East; and the industry to-day has simply begun. In the region to which this discussion is limited, the total stand of accessible timber on both government and privately owned land, may be placed roughly at twenty billion feet. The present annual cut is less than two hundred million. I know personally of five large mills, and six small ones, which plan to begin cutting within this area in the near future. These proposed operations will more than double the present output, and indicate clearly the status of the industry.

Nor are the lumbermen alone in entering in and possessing this land of mighty resources. Every cañon has its line of survey stakes. The recorders' offices are piled high with notices of water appropriation, until one official was led to remark: "It is a mighty good thing for the country that the mountains do not contain half the water that has been located, or the days of Noah would be repeated." I know of but four electric power plants now in operation in this stretch of the Sierras. There are at least thirteen for which definite plans have been made or construction begun, and as many more in contemplation. The expansion in lumbering is but a part of the whole present development of the western Sierras.

This movement of the last fifteen years has been clearly reflected in stumpage prices. When operators began to acquire timbered land about 1890, sugar and yellow pine

stumpage was bought, in many instances, for fifteen cents per thousand feet. Fir and cedar were too worthless to be figured in the sale. To-day, the average price of pine stumpage in the western Sierras could not be placed at less than $1.50 per thousand, an increase of 900 per cent in fifteen years. In some sales, $3 has been paid for sugar pine and $2 for yellow pine. Fir and cedar are now recognized, though inferior, commercial timbers and are rated at twenty-five to seventy-five cents per thousand feet.

All this bears directly upon the administration of timber in the National Forest. Our present market, while good, is beyond comparison with the market which the future promises. The meager transportation facilities which are now available will be enormously extended in the general development of the region. In adjusting stumpage prices in a number of timber sales during the past year, a charge of $2 per thousand feet had to be reckoned to cover the construction which was necessary in order to get to the timber. This factor, on the average, will gradually decrease. Nor should we lose sight of the steady increase in the eastern demand for Sierra lumber which, to a large degree, is coincident with the exhaustion of white pine. Altogether, it is a safe conclusion that stumpage prices in the Sierras will increase in the future, not necessarily in the same percentage ratio as in the past, but at an equal or greater rate when measured in the actual money value of a thousand feet of timber. From two years' actual observation of market conditions, I estimate that much of the more accessible timber of the Sierra Forests is increasing in value, by simply standing uncut, at the rate of fifteen or twenty per cent a year. From a purely commercial standpoint it would seem that we ought to hang up our marking axes and wait. On the other hand, almost the first thing that impresses a forester in a typical west Sierra stand, is its urgent need of cutting.

On cruising an average township, we find a stand ranging

from fifteen to forty thousand feet to the acre. The forest varies from pure yellow pine at the lower elevations and on dry exposures to nearly pure fir toward the upper limit of merchantable timber. The most typical and valuable stand is that of the middle elevations, between 4,500 and 7,000 feet, where the two western pines, sugar and yellow, occur together among white fir and incense cedar.

The characteristic form of this forest is in pure, even-aged groups. In deep, moist soils along ravines, in coves and benches, and on the north slopes, one sees bunch after bunch of six or eight mature sugar pines of nearly the same size. Where sugar pine seedlings and saplings occur at all they are usually in groups under broken cover or in narrow openings in the stand. On the same sites fir and cedar crowd the sugar pine closely and bunches or large patches of these species occur in among the groups of sugar pine. Yellow pine, in this mixed forest, seeks the drier and warmer sites on the tops of ridges and southern exposures. Here it also is commonly found in large even-aged groups, from open bunches of mature trees to dense thickets of saplings and seedlings.

Attractive as it is in general outline, at least three bad features of the virgin stand quickly impress the forester. The first is the widespread over-maturity of the timber. In sugar and yellow pine, this is due to sheer old age and to the weakening and scorching effects of repeated fires. In fir and cedar two very destructive fungi which attack the middle-aged and older timber hasten the decline of these less hardy and shorter-lived species. Everywhere through the virgin forest there are dead, stag-headed, and fire-hollowed trees in every stage of decline. In estimating a number of tracts in the west Sierra Forests, a rough classification of the timber of merchantable size was made according to its condition. The trees were tallied as *dead*, *decadent*, *mature*, and *thrifty*. Trees were classed as "deca-

dent" which have passed maturity and are declining steadily in value, which, in a word, must be cut at once to utilize the timber which they contain. Under "mature" timber, were tallied the trees which are practically at a standstill, which may be left for another ten or fifteen years, but not longer. The thrifty members of the merchantable stand are the more vigorous growing trees, which under rough selection cutting at forty or fifty-year intervals may be safely left for future yield. The percentage of these various classes in the total stand is a fair index to its condition. In sugar and yellow pine the percentage of dead trees ranges from one to five; of decadent, from ten to twenty-five; and of mature, from thirty to fifty. In fir and cedar the percentage of dead and decadent trees is still higher. Frequently thirty per cent of the trees of these two species, twenty-four inches and over in diameter, are unmerchantable from advanced decay.

The second adverse condition which is striking all through the Sierra Forests is the large and apparently increasing proportion of inferior species. On an average section, sugar pine forms from fifteen to twenty-five per cent of the total stand, and yellow pine another fifteen or twenty per cent. Except at the lower elevations, white fir forms a full third of the merchantable trees and a much larger proportion of the younger growth. Incense cedar is second only to fir in persistence and usually outnumbers both sugar and yellow pine, especially in the young growth of all ages.

Fir and cedar are not alone inferior in the commercial value of their timber. Nearly all of the larger trees of these species are so unsound from the attacks of fungi that a straight cull of twenty-five to forty per cent on the log scale is necessary to approximate the actual mill cut of merchantable lumber. Heart-shake is a second inherent defect of white fir. In the seasoning and finishing yards another ten or fifteen per cent of this timber is rejected on

account of heart seams and cracks which unfit it for any but refuse lumber.

The very large proportion of fir and cedar in its reproduction is the worst feature of the west Sierra Forest. Both of these species are prolific seed bearers, producing good crops at least every alternate year and frequently every year. The seedlings of fir and cedar are much more tolerant of shade than either of the pines. Except at lower elevations and on very warm exposures, where yellow pine grows in pure stand, dense thickets of fir and cedar crowd the young pine down to one fifth or less of the reproduction.

The third unfavorable feature of the west Sierra Forest is the area, large in aggregate, on which the stand is very open or has disappeared entirely. This is the effect mainly of intermittent fires which have swept the lower timber belt since early Indian times. The usual fire of this region, like the ground fires of the southern pineries, removes leaf litter and humus and kills young growth, but simply scorches the butts of larger trees. Its worst effect is the dense coppice of ceanothus, manzanita, bear clover, and other chaparral species which sprout so rapidly and thickly after a fire that the slower seedling reproduction of the Sierra conifers is largely precluded. Each successive fire leads to a denser growth of brush and harder conditions of reproductiion of pine, fir, or cedar. In time, the older timber succumbs to scorching and weakening at the butt and the forest passes gradually into chaparral. All through this forest one is impressed by the enormous acreage which at some time has been forested and is capable of growing pine timber, but which is now barren or nearly barren of tree growth. Even on the forested areas, much of the stand is open and irregular. Not one-third of the productive capacity of this belt of forest land is now being utilized, and with dense patches of chaparral blocking reproduction there is but little prospect of natural betterment.

The conditions which have been briefly described indicate clearly what the Sierra Forests need silviculturally. The ripe and dying trees should be cut, both from simple economy and to remove material which, by breeding fungi and feeding forest fires, threatens the well-being of the whole stand. The proportion of fir and cedar in the coming forest should be reduced by cutting out the seed bearers of these two species as far as practicable, while keeping up the seed production of sugar and yellow pine as closely as possible to its present level. More than this, better conditions for the germination and thrifty growth of sugar and yellow pine can be secured. All that yellow pine needs is soil and sunlight. Except at the lower elevations, where drought becomes an important factor, cut clear patches an acre or so in size, rip up the brush and expose mineral earth as any steam logging engine will do, leave plenty of seed trees about, and this hardy species will care for itself. Sugar pine requires much more careful handling. Its seedlings are so sensitive to drought that a large majority of them die in the first two or three years under the intense evaporation of the dry summer months. Except in deep cañons on north slopes, or other naturally shaded sites, small patches should be cut clear on sugar pine land in order to furnish enough light to start young growth, together with partial shade at the sides to protect it during the first critical years. Sugar pine is so deficient in seed bearing, and such a large percentage of its nuts are destroyed by squirrels, that seed trees of this species especially need to be numerous and well distributed.

A still greater need of the Sierra Forests than either of those mentioned is the re-stocking of the chaparral areas which are within the timber belt on forest producing soil. On the smaller brush patches, scattered through the timber, much can be done simply by the operations of logging

as now conducted. A four-foot pine log, yarded by donkey engine and cable, rips out a clean swath through the brush and plows a great furrow in the soil. This process, which so frequently works an injury to the forest by killing young growth, can readily be turned to its benefit by clearing a fine seed bed through the brush here and there where seedlings cannot now gain a foothold. A few trees thus started will gradually kill out the chaparral around them, and in time reclaim these barren areas.

On the larger patches of chaparral, natural reforestation must be aided by planting; but throughout the immense acreage of open, scattered timber a much better stand than is now possible can be secured by logging.

I believe, therefore, that logging under careful marking and supervision can do much for the permanent improvement of the west Sierra Forest by removing the over-ripe and dying timber; by increasing the proportion of sugar and yellow pine; and by extending the actual area of forest as opposed to chaparral.

Two radically conflicting policies thus present themselves: From one view point the Sierra supervisor must say: "Hold our timber for the magnificent markets and high stumpage prices of twenty years hence;" from another: "log the forest now for its own good." The situation, to my mind, calls for a system of cutting which will improve the forest without sacrificing too much of the great and increasing commercial value which it represents. And it goes without saying that this system, to be applicable on any considerable scale, must be extremely simple and adapted to present-day logging methods. The plan suggested may be summed up in a single sentence: "Cut now, but cut as lightly as possible."

Without attempting any exact calculation of sustained yield, the forest should be logged under a rough selection system, by groups or single trees, with a cutting interval

of forty or fifty years. As the standard in cutting sugar and yellow pine, we should leave every tree which from its general thrift gives evidence of remaining sound and merchantable for another forty or fifty years. The trees which will not stand this test should be cut, except in instances where no seed bearers of the thrifty class are present. In such cases more mature trees must be left for seed, with the expectation that the value represented by their timber will be lost through decay before another cut can be made. I do not think that successful regeneration of pine can be secured in this region with less than four full seed-bearing trees to the acre, and in the case of sugar pine it should be five or six.

Obviously, no diameter limit will apply in marking sugar and yellow pine under this method. In many cases, weakened and unsound trees as small as twenty-four or thirty inches must be cut. In other instances, sugar and yellow pines fifty inches in diameter and containing 5,000 feet of lumber, which are still in the full vigor of growth and seed production, should be left. Marking is a matter of nice judgment in determining, from the shape and condition of its crown, the soundness of its butt, the character of its bark and other evidences of age and health, the thrift of each tree and its ability or inability to stand for another forty years.

In culling out the riper sugar and yellow pines, danger of windthrow can in the main be disregarded. The average stand of the Sierra pineries is comparatively open and, at least as regards sugar and yellow pine, the trees are so wind firm that their safety is not endangered by cutting out half of the stand. The peculiar needs of sugar and yellow pine reproduction, however, must be considered as far as practical in marking. On yellow pine soils the cutting should tend more toward the group system, with openings of good size, and the remaining trees bunched together to

admit plenty of light for yellow pine regeneration. On the moister and better soils, where sugar pine is the species to work for, the opening should be small to protect the young growth from drought. On such sites the selection cutting of pine should be more by single trees or small groups, with as few large breaks in the cover as possible.

Much can be accomplished also by leaving trees which are well located for disseminating seed. The best locations for yellow pine seed trees are the tops of ridges and the brows of warm, exposed slopes; for sugar pine, the heads of little coves and pockets, the brow of a north slope, or along the slope itself just above a bench or swale. In such locations it is often best to leave even mature pines, if necessary, in order to insure good seeding with the right kind of seed.

In marking, furthermore, the present young growth of pine should be carefully watched and aided. The bunches of young sugar and yellow pine need room and light, care being taken in the case of sugar pine to avoid too great exposure. By utilizing and improving these groups of young pine which are already established, the nucleus of a good second growth can, in many cases, be left on the ground when cutting is completed.

Fir and cedar should be cut uniformally to as low a diameter as they are merchantable, or an average, in Sierra logging camps, of nineteen inches. It is both impossible and undesirable to eliminate these species altogether. The younger fir and cedar, under merchantable size, will aid greatly in protecting the ground from excessive evaporation after cutting and in sheltering the bunches of sugar pine which we hope to start. The main point is to reduce the proportion of fir and cedar in second growth by reducing seed production as far as practicable.

The irregularity of the virgin Sierra Forest will, of course, make it possible for us to realize the ideals of this

system of cutting but seldom. We can simply stick to the main principle of leaving trees that will stand for another forty years and cutting trees that will not, with occasional variations, as indicated, in order to better the conditions for pine reproduction. The "improvement" feature of the cutting must be put first, every possible sacrifice being made in the interest of the second growth and the permanent value and productiveness of the stand. This concerns directly two practical difficulties which are frequently met. The first is the large number of old and rotten fir and cedar which are worthless to the lumbermen, but which, if left standing, will produce and scatter immense quantities of seed for several years. As a fixed principle, fir and cedar too unsound for lumber should be dropped or girdled. This may be done by the ranger force, if adequate, or by the lumbermen under a definite clause in their contract. If necessary to make this feasible, a reduction in stumpage rates should be allowed. A second obstacle is that the reservation of all thrifty pines, of whatever size, reduces the cut of timber per acre and increases the cost of logging. Even reserving every thrifty pine, however, a cut of 12,000 to 18,000 feet per acre can usually be secured, and the additional cost of logging is not appreciable. Where there is real foundation for this objection it also should be met by a reduction in stumpage prices, not by a closer cutting of the timber. The interval for cutting has been placed at forty years in the belief that a smaller cut than is thus secured would not be practical under existing market and logging conditions.

Under this system of cutting, as roughly followed in two or three instances, from 8,000 to 12,000 feet of merchantable pine timber are left per acre. These are the younger and thriftier trees which will form the nucleus of the next cut forty or fifty years hence. In that time they will easily add sixty per cent to their volume and a much greater percent-

age to their value. On this portion of the merchantable stand, or at least one-third of the whole, we will thus reap the full benefit of the increasing stumpage prices which were noted in the beginning of this article. Meanwhile we have reversed the proportion of pine seed trees as compared with fir and cedar, and we have secured through logging a much better seed-bed for pine, especially in the patches of chaparral, than the virgin forest affords. Of the mature timber, which is cut and on which the increase in market values is lost, a large proportion would be a total loss through decay within a comparatively few years.

Intensive methods of forestry, and especially the planting of the barren areas of chaparral, should follow as rapidly as possible. The plan outlined is suggested only as a simple method of cutting, which will meet the immediate demand for conserving timber values, and at the same time begin the needed improvement of the forest.

SOME GOVERNMENT TIMBER SALES IN THE SOUTHWEST FROM THE PRACTICAL AND TECHNICAL STANDPOINT

T. S. WOOLSEY, JR.

Delivered before the Society April 18, 1907

I have been asked to write a short article for presentation before the Society, and have chosen for my subject the timber sales on the San Francisco Mountains National Forest. I am sorry my experience is so limited, and that I can base my paper only on the operations on one Forest in the Southwest. On the other hand, I suppose the amount of timber actually cut on this Forest during the past year exceeds that of all the other Forests in the region.

The commercial western yellow pine forest is found on elevations varying from 6,000 to 8,000 feet, on a mesa, or tableland, dotted with volcanic buttes and mountains. For all practical purposes, the western yellow pine is the only commercially important species, although a small amount of white fir and red fir has been logged, and cedar and piñon are used to some extent for fuel, posts, and corral poles.

The great problem on this Forest was to handle a timber sale business, which was rapidly increasing in importance, without available men trained to the work. In addition to the regular government sales, there has been the marking of seed trees on railroad land and the supervision of this cutting under rules drawn up by the General Land Office.

As one looks back over the timber sales, whether made and carried out by ones self or others, it is easy to find fault after the cutting has been completed. Yet as a part of early Forest Service history, and since it will be simpler and easier to avoid similar errors in the future by digest-

ing the mistakes made, I have an excuse for re-hashing bygone troubles.

The first sale was to the Dennis Lumber Company, dated May 25, 1905, and the original contract embodied the following rules: "A diameter limit, breasthigh, of thirteen inches, with four seed trees per acre; stumps not higher than eighteen inches; bole utilized to eight inches inside bark, where merchantable; and the usual stipulations regarding brush piling, fire, and protection of young growth."

There were four points in this first sale which were unsatisfactory: (1) the estimate, (2) the marking, (3) the scaling, and (4) the logging.

The cut overran the estimate by more than sixty per cent, and might possibly have tended to lower the stumpage prices.

The marking in this sale was practically on a seed tree basis, since the diameter limit of thirteen inches did not provide for a future cut or for sufficient seed trees. In marking, the contract was followed too literally, since the four trees were usually retained even if unsuitable seed bearers. The lumber company protested at not marking these large over-mature trees for cutting.

As a result, the cutting was inspected by a general inspector, and on November 9, 1905, the Flagstaff office was telegraphed:

> ". . . . instructs you to mark and allow cutting of extra seed trees."

The local forest assistant believed these orders partially incorrect, and only a portion of the seed trees were marked. His judgment was backed up by the following telegram on January 16, 1906:

> "Do not allow cutting of extra seed trees. . . ."

I believe that the proper medium was chosen, although a large number of seed trees were marked for cutting under

the first orders received. Possibly there are now on the cutting area some dozen seed trees that are over-mature and poor seed bearers, which should have been marked, but, on the whole, the forest is now in good condition for reproduction.

The scaling was done by a ranger who had had no experience, and consequently it was very unsatisfactory. To start with, very little was allowed for rot, and the result was a protest from the company. After an inspection of the scaling, on October 6, the Flagstaff office was instructed from Washington:

> "In scaling logs unsound in part, mark on each log the complete scale, sound and unsound, in such a manner as to make the figures show the exact amount of sound timber in the log and the amount of deduction for unsoundness. . . ."

Subsequent events proved that this was an unwise order. Whenever the log appeared to be scaled too high, the government scaler was called to the mill and shown that his scale should be lowered, and before long his scale became pretty well demoralized. When I inspected the scaling during November, it appeared to be so bad a system that the order of marking the scale on each log was countermanded. A few weeks later a scale study of the actual mill-cut for three hundred and sixty-five logs was made, with the following results: The cut, including mill culls, overran the scale by forty-two per cent; the sound logs overran twelve per cent. The result of this study, followed by detailed instruction from the expert scaler, corrected this misunderstanding, and the scaler has done fairly good work on other scales, but what it cost the Government can be only a conjecture.

The idea of running unsound logs through the mill under proper supervision was never clearly understood by the Washington office. The Office of Management wrote in part:

> ". . . . Mill studies in mills belonging to purchasers of reserve timber are very apt to lead to misunderstanding and dissatisfaction, and you will please not authorize any more of them. The sales are made on a basis of the Scribner Rule, Decimal C, and not on the basis of what logs will actually saw out in the mill."

While the above statement is true for sound logs, yet in scaling unsound logs, allowance must be made for what the mill owner will lose through defect, and this amount can only be arrived at by a thorough knowledge of "how logs saw out."

Partly through a misunderstanding and partly through the fault of forest officers, the logging was not in accordance with the contract. As soon as the snow melted, I examined the sale and found that over twenty-six thousand board feet of timber, merchantable under the contract, had been left in the woods. There were fifty-eight sound logs, or seven thousand and thirty feet; seventy-six partially unsound logs, (one-third to one-half sound) or six thousand six hundred and ten feet; and three hundred and seventy-two tops, or twelve thousand, six hundred and ninety feet.

This was very wasteful logging, especially when one considers that the haul to the mill was only from one-fourth to one mile. The above timber was charged for at the stumpage rate of three dollars per thousand, and the lesson taught the company, that contracts must be closely followed, was beneficial and there never has been any real trouble since this settlement. In other respects, except that no dead timber was marked or cut, the sale was satisfactory. The young growth was not damaged, no unmarked trees were cut, the stumps were low (sixteen inches), the brush piling well done, and only a few marked trees were overlooked, and these happened to be healthy "black jack" (i. e., *young* western yellow pine). The monthly reports, on Form 820, did not disclose the true state of the cutting, and in inspecting a sale these should be first examined, and then if they prove

false, the attention of the ranger should be called to their inaccuracy. The catalogue of errors in handilng this sale shows how much can be lost to the Forest Service through ignorant management and inspection.

The Saginaw and Manistee Lumber Company sale of October 11, 1905, was the second important sale on this Forest, and the first large one in the Southwest. The contract stipulated: "A sixteen-inch diameter limit inside bark in the tops, and the usual rules regarding the details of logging." When the contract was made, the protest regarding the reservation of so many seed trees in the first Dennis sale had just come up, and the Saginaw and Manistee Lumber Company were given to understand that they were purchasing all trees over sixteen inches, breasthigh. When the work commenced, the superintendent waived the right to bushy "black jack," but from the silvicultural standpoint there ought to have been *no healthy* "black jack" cut in this sale. On the other hand, the area is isolated and the odd sections and homesteads have been "skinned," so there would not be sufficient timber for a second cut for many years, and some twenty miles of loggong road is necessary to tap the logged areas. Taken as a whole, the forest is in fair condition after logging, and I feel sure that in twenty to forty years there will be good reproduction over most of the area included in this sale, with the exception of a few sections. Many areas are sure to be fully stocked if fire does not get in and destroy the reproduction already existing.

This sale, from the start, has been an extremely troublesome one, and the Forest Supervisor handled it with skill and judgment. The principal bone of contention has been the scale, and on looking over the files I find that twenty-five letters of complaint have been written by the lumber company in regard to this matter. They claimed the scaling had been done by incompetent range riders, and they

object to scaling logs over sixteen feet as two logs. This latter point is of minor importance, since this method of scaling increases the scale from only one to two per cent where from fifteen to seventeen per cent of the logs are over sixteen feet. The expert check scaler has probably saved the Government $5,000 to $10,000 through his control of the scale; and, though in some cases the scaling has been too high, I believe, on the whole, it has been accurate and fair. For instance, in scaling dead wood, only the heart is scaled, and a very liberal treatment is thus given the purchaser. The main and vital point at issue is whether the scale should aim to include merchantable mill culls, and if so, what proportion of these culls are actually merchantable.

In a later sale of some 300,000 feet made to this company, the total government scale was only two per cent over that of the company, yet during the four weeks ending August 29, 1906, at one camp they claimed a difference of over seventy-nine thousand feet. Up to July 12, 1906, the company's scale was reported as seven thousand and thirty-one M board feet, and the Government seven thousand, three hundred and fifty-seven M feet — a difference of four and six-tenths per cent. The Government scale will prove large when the mill run is totalled at the end of the sale for several reasons: About sixty thousand feet of the company's logs were burned in skidways by being set on fire by the logging engine; some sixty-eight thousand feet have been left in the woods, and some one hundred thousand feet have been cut into piling and stulls. The continual squabble about the scale is really a compliment to the honesty of the Government scalers.

A number of rather miscellaneous problems arose as the sale progressed:

(1) Payment for meals and horse feed by rangers was insisted upon, and, it seems to me, in big sales it is desira- to have separate boarding facilities for forest officers.

(2) Several isolated areas were omitted in the original sale, and an additional sale was made to cover them.

(3) Where all trees over a certain diameter are sold, it hardly seems necessary to mark all trees, yet, of course, this should always be done, except possibly on a simple seed tree proposition. Marking the seed trees to be retained is often cheaper than marking the trees to be cut.

(4) The utilization of dead timber was a puzzling proposition. The trees looked good, and more than one inspector believed more should have been cut. Yet, after careful examination, it was found sun checks made most of them unmerchantable, and in cutting seventeen thousand, and forty-six thousand feet of timber, the dead timber cut amounted to only nine-tenths of one per cent of the green. Most of this was made up by small dead trees which make excellent stulls that are light to handle and easy to peel. As timber sales progress on this Forest, a much larger percentage of dead timber will undoubtedly be cut.

(5) I recommended that each scaler be required to keep a tally of the amount allowed for rot on each log, but the plan was not approved by the Washington office and the system was not enforced, although a few men kept it for their own satisfaction. These figures, kept on all sales, would prove of great scientific interest and be of value in cruising. The figures are easily kept by writing the number of feet deducted for rot over the log number in the book.

(6) Another question was how much rot would make a log unmerchantable. The general rule was established that logs which would scale one third the full scale must be either logged or paid for. This rule was not, of course, applied literally, but was varied to meet practical conditions. Logs near the railroad, scaling one-fourth their full scale, might be logged, while those difficult to log and expensive to haul, might be left, even if one-half sound. On the

whole, this one-third rule has held since the sale started. It is a rule which I believe has been enforced in Michigan in private enterprises.

(7) When most of the timber had been already marked (February 14, 1906), the following ruling was made by the Washington office:

> ". . . . to facilitate marking, the height at which the diameter is to be measured has been changed to three feet. This rule will be adhered to in all sales."

I cannot condemn this rule too strongly. When the technical standard on the Forests progresses the delusion of a diameter limit will be abandoned, and the marking will be based on silvical principles and not on false, ironclad mathematical reasoning. The reason for marking on a basis of diameter measured three feet from the ground will be void, when the diameter limit system is abandoned elsewhere as it has been at Flagstaff. If the three-foot system takes the place of the standardized "diameter breast-high" in scientific work, there would be further "chaos" in comparing European figures with our own.

(8) From actual experience it seems advisable to have all scalers provided with substantial iron lock boxes so that the scale books cannot be lost, or borrowed by employes of lumber companies, as might be done by a hostile camp boss to discredit the work of the government scaler.

(9) The method of estimating was as follows: The estimates and forest descriptions were made at the time of marking the timber to save expense, and the whole operation cost about three cents per thousand feet. The diameter of all "black jack" (young western yellow pine) and the diameter and number of sixteen-foot logs of "yellow pine" (old western yellow pine) were ocularly estimated as the trees were marked. The ocular estimate for the sale by a local cruiser was twenty-five million feet; the government estimate by the above method, twenty-eight and two-tenths

million feet, and the probable cut will be thirty million. A comparison of the actual cut and estimate shows that thus far the cut has exceeded the estimate by about thirteen per cent.

(10) During November, 1906, the expert check scaler was telegraphed to give the Saginaw Company a detailed scale of each log. The way this order would work out is somewhat as follows: If it had been followed, there would undoubtedly have been friction, complaints, and the man in charge would have been blamed for not having things go smoothly. Fortunately the order was revoked upon protest, and after two months consideration, modified. I believe even the amended order, which allows purchasers to inspect the detailed scale, will be a "trouble brewer" for the local offices, but my experience is too limited to permit any definite opinion on this point. I fear it is too often true that the local officers "get it coming and going" in dealing with the Washington office regarding these details.

(11) With additional sales on this reserve it has been found desirable to systematize the control of woodswork, issuing explicit instructions covering every detail of the work. If one sale is managed on a slightly different basis, there is sure to be complaint. The methods, of course, conform to "The Use Book," and scale book instructions, and in addition, cover the method of scaling and all branches of woodswork, control and inspection, marking seed trees on railroad land, and timber on government land, brush piling and burning, check scaling, and reports. These definite instructions have systematized the work and it will undoubtedly be improved in the future. In this connection it should be borne in mind that perhaps the most important consideration in successful timber sale work is to give the forest officer in actual charge sufficient authority, and not to interfere with his work—e. g., all orders regarding details should be given through him and not independently by the

supervisor or assistant directly to the camp bosses. The forest supervisor at Flagstaff always recognized the fact, and accordingly he was not usually bothered with complaints regarding minor details.

(12) In order to familiarize the rangers with woodswork and cruising, a number of them were set to collecting data for a local volume table which was badly needed on this Forest, and others in the Southwest. Some 2,800 trees were measured and the results are given below, since the tables are in slightly different form from any made before, and are therefore of unusual interest. There are three tables. Table No. 1 is for "black jack," and No. 2 for "yellow pine," each on a diameter basis, while No. 3 for "yellow pine" is on the basis of diameter and the number of sixteen-foot logs each tree contains. In tables No. 1 and No. 2, the average number of sixteen-foot logs is given for each diameter, merely as a guide, and by these figures it is possible to tell the average merchantable height of the trees used as a basis for the table. The logs were measured to a merchantable top limit of eight inches inside bark, and in scaling by the Scribner Decimal C, all logs were taken as straight and sound. In using these tables for cruising it would therefore be necessary to dock figures from three to fifteen per cent for defects. The figures are by three-inch classes.

TABLE NO. 1.—"BLACK JACK"

Inches breasthigh	*Volume Board feet*	*Average number 16-ft. logs*
14	7	1.5
17	14	2.0
20	25	2.5
23	40	3.0
26	58	3.5
29	76	3.5
34	92	4.

TABLE NO. 2.—"YELLOW PINE"

Diameter breasthigh Inches	*Volume Board feet*	*Average number 16-foot logs*
14	11	2.0
17	19	2.5
20	31	3.0
23	48	3.5
26	71	3.5
29	102	4.0
32	141	4.5
35	191	4.5
38	233	5.0
41	263	5.0

In comparing tables No. 1 and No. 2 it is interesting to note the great difference between the volume for "black jack" and "yellow pine" of the same diameters. I believe other volume tables for this species have not been thus differentiated.

TABLE NO. 3.—"YELLOW PINE"

Diameter breasthigh Inches	*Merchantable lengths.* Volume—Board feet*					
	I	*II*	*III*	*IV*	*V*	*VI*
14	6	10	14	19		
17	10	16	21	27		
20	16	25	31	40	49	
23		38	46	56	68	
26		53	64	78	92	106
29			87	104	120	136
32			114	134	153	171
35				171	191	209
38				206	228	245
41				236	264	280

* Sixteen-foot logs.

In all these tables it will be noted that the number of board feet is given in decimal figures. All the above mis-

cellaneous problems and items came up at the first Saginaw sale.

The Dennis sale of January 5, 1906, was estimated at two hundred and ten thousand, and cut three hundred and forty-five thousand, marking an overrun of over sixty-four per cent. The stumpage price was three dollars. The marking in this sale removed all the western yellow pine, while all "black jack" (young western yellow pine) were retained. The contract was similar to the Saginaw sale. At first the company did not cut the tops to the proper limit, but the lesson they learned in the first sale (you will recall they were charged for merchantable tops and logs left in the woods) proved effective, and when the sale was finished there was no fault to be found with the cutting. An interesting figure was secured from this sale: In cruising, the problem often presented itself as to how much should be deducted from straight and sound figures for rot and breakage. In this sale there was a net loss of between nine and ten per cent by loss through defects and breakage of timber in felling and logging. Possibly the rot was higher than the average for Arizona, but I believe it would be safe to deduct three to fifteen per cent from all straight and sound cruising figures, according to the locality.

The original Saginaw sale was made hurriedly to meet the requirements of advance cutting, and the sale of May 31, 1906, was made to cover two small areas that had been overlooked. It was estimated at three hundred and fifty thousand, and actually cut three hundred and sixty-three thousand, or an overrun of four per cent. The total cut included about one per cent dry to ninety-nine green. The marking on one area reserved all "black jack" with a few seed trees where they were necessary. On the other there happened to be a dense understory of seedlings sufficient to form a future forest. The marking here reserved a number of "safety" seed trees in case of fire, which were trees

sufficiently large to escape the average burn. Here the bushy "black jack" were not always proper trees to leave, since they would interfere with the already completed reproduction and would not escape a fire. Therefore a considerable number of "black jack" were marked for cutting, and taller older trees, even though the less desirable for seed were chosen, so as to have trees safe from fire and well above the understory. The cutting was in accordance with the contract and entirely satisfactory.

The third Dennis sale which was dated May 3, 1906, is still being cut. The estimate made by two rangers using a volume table, has proved very inaccurate. The first section logged was estimated at seven hundred and five thousand, and actually cut fifteen hundred and ninety thousand, an overrun of over one hundred per cent. The error was due to underestimating diameters. The original recommendation for the sale included the following:

> "Timber mature, diameter limit sixteen inches, no healthy young trees 'black jack' to be cut except in thinnings, $3 per 1,000 for green, fifty cents per 1,000 for dead, with provision that all dead trees be felled whether merchantable or not."

The object of this last recommendation was to have dead trees felled on account of fire protection, and to have a larger amount of dead timber hauled from the woods. Taking into consideration that the percentage of dead timber cut is only about one per cent, the financial loss would be small. This lower price for dead timber was not approved, however, and it was sold at a net price of three dollars. It is a debatable question which is rather complicated in its scope. How much more dead timber would be utilized? Would it offset the lower price? I fear a financial loss; but in a compact sale it might be worth while to provide for the cutting of all dead timber for fire protection. There was some talk that the low price of two dollars and fifty cents, instead of three dollars, in the first Saginaw sale, was

due to the inclusion of dead timber in the contract, and since so little was found merchantable, the loss has been possibly over fourteen thousand dollars. The cutting thus far in this Dennis sale has been satisfactory, but can certainly be improved, since on one section some healthy "black jack" were marked and cut through a misunderstanding on the part of the forest assistant.

Owing to the recovery of a homestead, an additional sale was made the Dennis Company on the same basis as the last sale mentioned. Just after the contract had been approved it was recalled to Washington in order to change the diameter limit. This shows clearly that the Washington office has not yet grasped the silvical problem at Flagstaff. The forest is composed of young western yellow pine, "black jack," and old and over-mature western pine, or "yellow pine." This is the same local distinction as that of "shell bark" and "pig iron" Norway in Minnesota. The correct marking, with variations of course, should save all these healthy "black jack," except where too thick (which is seldom), and should cut all the mature timber except where the trees are needed for seed. It is a very simple operation which any ranger can understand. Even where badly needed and where blanks will be formed by their removal, distinctly over-mature trees should not be reserved for seed or cover. The reason is apparent. During the first periodic drought these seed trees will probably be weakened and later infested by insects, which are likely to spread to the healthier trees. Thus the final outcome would be a distinct loss in both financial and silvical results.

The last sale made on the Forest — the Greenlaw sale, which is now being advertised — will be excellent. No healthy "black jack" are now being marked, all healthy trees are now being reserved along roads, and necessary healthy seed trees are being retained elsewhere. It is a simple system of marking, yet the forest assistants can save

or lose many times the value of their own salary each day by good or poor judgment in selecting trees to be cut. The cost of marking this sale for about eight and one-half million feet marked during January, in deep snow, has averaged two and one-tenth cents per thousand in actual time, and three and eight-tenth cents, inclusive of days lost through storms or holidays. One problem in this sale has been the question of the inclusion of additional timber lying in the same watershed, and of the total amount of the sale, which is made for ninety million feet. It is clear that the Forest Service can have no strict policy limiting the amount to be included in any one sale. Each case must be considered solely on its merits, rather than on a red-tape basis. Logging and selling by watersheds seems preferable to logging and selling by amounts limited by a fifty million foot maximum.

As one looks back over the sale work on the San Francisco National Forest, it is easy to see how things could have been bettered, yet it is pleasing to note that as the work has progressed there has been a steady improvement along the line, and by the end of 1908 I believe many of the points we are now in doubt about will be cleared up. A preliminary working plan is now under way which may solve some of the problems. At present, on this and on many other Forests, the great question is; how much timber ought to be sold each year, and how should the annual cut be regulated? Should all the over mature timber be cut as rapidly as possible, or should the Government look more strictly to a sustained annual yield and to the future high stumpage prices? At Flagstaff the annual yield of available government timber I estimate roughly to be between ten and twenty million feet, and yet, during 1907, there will be cut on government land at least thirty million, and possibly forty. The timber sale policy of "America's greatest trust" is certainly a complex problem.

There was issued only one number of Volume II. The next number is Volume III, No. 1.

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